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City of Greater Sudbury

SCADA, Controls & Instrumentation Systems Design Standards Manual

Version 1.0

April 2018

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Date	Section	Version	Details of Revision	Revision By
April, 2018	All Sections	V 1.0	First Release	

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General Requirements

1 Introduction

The City of Greater Sudbury has developed this SCADA, Controls and Instrumentation Systems Design Standards Manual for use by Consultants, System Integrators, Contractors, City of Greater Sudbury Staff, and any other parties involved in the design and implementation of the SCADA, Controls and Instrumentation portion of any water and wastewater capital works or maintenance projects for the City.

The intent of the SCADA, Controls and Instrumentation Systems (SCIS) Design Standards is to define the City of Greater Sudbury's design and implementation philosophy and preferences. It is also to document the system requirements for any SCADA, Controls and Instrumentation Systems and Communications Networks to be developed or upgraded for the City of Greater Sudbury water and wastewater facilities.

All Consultants, System Integrators and Contractors will reference this document when providing engineering and construction services related to SCADA systems. As well, the City of Greater Sudbury's engineering, and operations and maintenance staff will reference this document as required while performing their activities related to SCADA systems.

This document should not be viewed in isolation of any other City of Greater Sudbury Standards. Associated standards may be referenced throughout the SCADA, Controls and Instrumentation Systems Design Standards documents, as they may modify and/or clarify the requirements set forth within them. Also, use of existing industry standards such as IEEE and ISA will be made throughout the set of standard documents.

2 Document Revision Control

In order to request a revision and/or expansion to the SCADA, Controls and Instrumentation Systems Design Standards Manual, the initiator must complete the Revision Request Form in Appendix A-2 (applicable to all Standards' sections, with the exception of the standard software routines), or the Software Revision Request Form in Appendix A-3 (applicable to software routines that are referenced in the Standards, to be requested/used by the System Integrator during construction stage as applicable), and submit it to the City of Greater Sudbury Water and Wastewater Services Compliance Supervisor, who will coordinate with subject matter experts in the City of Greater Sudbury Water and Wastewater SCADA group to review and address all revision request forms. Following approval, a revision to the relevant section(s) of the Standards will be prepared and published.

An amendment or revision to the SCIS Design Standards Manual may be issued as a complete document or as a complete section of the document. At the beginning of the SCIS Design Standards Manual, the document's Revision Record is included, where changes with version numbers and release dates are recorded for each section. In addition, each section's version number is shown in the footer of every page in that section. This version number will be updated to reflect new releases of the Standards.

All holders of the SCIS Design Standards Manual are responsible for ensuring that their document is maintained up to date. Old versions of the document or superseded sections are to be replaced by the revised document/sections.

The latest electronic version of City of Greater Sudbury SCIS Design Standards, including all appendices, will be available from the City of Greater Sudbury Engineering Standards website:

http://www.greatersudbury.ca/business/engineering-standards/.

3 Roles and Responsibilities

City of Greater Sudbury	The City of Greater Sudbury is the owner. The City of Greater Sudbury generally performs all tasks related to preparation and issuance of the project assignment, and to engineering services contract award. As well, the City of Greater Sudbury representatives review the work of the Consultant, Contractor, and System Integrator.
City of Greater Sudbury Project Team	The City of Greater Sudbury Project Team refers to the City's personnel assigned to a specific project that requires SCADA, Controls and Instrumentation systems design and implementation. The Team consists of the Project Manager, SCADA, and Operations and Maintenance specialists. Staff from other groups of the City of Greater Sudbury Water and Wastewater Services may be involved in the Project Team, depending on the project's size and complexity.
City of Greater Sudbury Project Manager	The City of Greater Sudbury Project Manager is the single point of contact for all communication between the City and the Consultant for the project, unless others are designated as contacts for specific purposes.
City of Greater Sudbury SCADA Group	The City of Greater Sudbury Water and Wastewater Services SCADA Group is in charge of administering the City's water and wastewater SCADA system, including managing the SCADA, Controls and Instrumentation Systems Design standards, maintaining/updating installed hardware, firmware and software versions and licenses, keeping/controlling revision of master list of IP addresses, master network drawings, and master copies of software programs. During the course of a project that requires SCADA, Controls and Instrumentation systems design and implementation, this group provides support related to application of the Standards, as well as a review of requests for deviations from the Standards and/or changes to the Standards, review of SCADA hardware and software deliverables such as those related to instrumentation PACs, networking, and review of all related customized programming and interfaces. They are also active participants in hardware and software Factory and Site Acceptance Tests. The SCIS Design Standards Leader for a project is assigned from this group as being responsible for enforcement of SCADA, Controls and Instrumentation Systems Design Standards on the project. The City of Greater Sudbury Water and Wastewater Services SCADA Group will also be responsible for any IT requirements on a project, as they will provide any required coordination with the City of Greater Sudbury IT group.
City of Greater Sudbury Compliance & Operational Support Supervisor	The City of Greater Sudbury Water and Wastewater Compliance & Operational Support Supervisor is the overall manager of the SCADA group.
City of Greater Sudbury Operations & Maintenance Group	The City of Greater Sudbury Operations and Maintenance Group consists of the support staff at the water or wastewater facility at which the project is being undertaken. They will be the principal group driving the development of the project assignment's Scope of Work, and will review deliverables for constructability, operability, and maintainability during the project. They are also active participants in Factory and Site Acceptance Tests. This group consists of

supervisors, operators, and maintenance personnel. The maintenance staff are responsible for maintaining all field devices, including instrumentation, PAC's, VFD's, Soft Starters, UPS's, and Process Equipment with associated controls.

Consultant — Project Design Engineers. The Consultant is contracted by the City of Greater Sudbury to perform the Scope of Work as defined in the project assignment. The Consultant generally performs all tasks for Pre-Design and Detailed Design including preparation/updating of Process Control Narratives and P&IDs. The Consultant will typically also represent the City of Greater Sudbury during the Construction phase, in the role of Contract Administrator. As the City of Greater Sudbury's representative, the Consultant will review all deliverables from the Contractor and System Integrator and provide comments to the City. The Consultant also participates in hardware and software Factory Acceptance Testing (FAT), Site Acceptance Testing (SAT), Commissioning and Training activities, and updating of as-built documentation for the project. In the case when a System Integrator is working without the services of a design Consultant, the Integrator is designated the "Consultant".

Contractor — The Contractor is contracted by the City of Greater Sudbury to perform the Scope of Work as defined in the tender package created by the Consultant during Detailed Design. The Contractor will purchase and install all controller, SCADA, and communications hardware, instrumentation and field wiring and networking, as specified, including conducting hardware FATs at the Contractor's facility, witnessed by the Consultant and the City of Greater Sudbury staff. The Contractor will also perform field calibration and verification of all installed instruments, devices and control loops, witnessed by the Consultant and the City of Greater Sudbury staff and perform the hardware SAT and operational testing and system performance testing, witnessed by the Consultant and the City of Greater Sudbury staff. The Contractor will also prepare the Operation and Maintenance Manual and submit to the Consultant for review at the appropriate milestones. Contractor will provide training, and will also provide required support during warranty period.

System Integrator — The System Integrator is a direct subcontractor of the Consultant or Contractor. The System Integrator will not be a subcontractor to the Electrical subcontractor, nor will it have its own subcontractors. The System Integrator will generally configure the PAC program and HMI program in accordance with specified Process Control Narratives. They will submit PAC and HMI programs to the Consultant and the City of Greater Sudbury for review to ensure compliance with specifications and the PCN. The System Integrator will perform the Software FAT at a facility within the City of Greater Sudbury area, witnessed by the Consultant and the City of Greater Sudbury staff. They will also perform the Software SAT and perform operational tests/system performance tests, witnessed by the Consultant and the City of Greater Sudbury staff. The System Integrator will update the Process Control Narratives to reflect the as-built state, provide training, and prepare the SCADA Section of the Operation and Maintenance Manuals and submit it to the Consultant for review at the appropriate milestones.

4 General Instrumentation Standards and Codes

All SCADA, Controls and Instrumentation work completed for the City of Greater Sudbury will meet the latest edition of the following Codes and Standards.

- Ontario Electrical Safety Code (OESC)
- National Fire Protection Association (NFPA)
- Canadian Standards Association (CSA)
- International Society of Automation (ISA)
- Canadian Electrical Manufacturers Association (CEMA)
- Institute of Electrical and Electronic Engineers (IEEE)
- National Electrical Manufacturers Association (NEMA/EEMAC)

5 List of Acronyms

The following list of miscellaneous, commonly used acronyms is applicable to all sections (volumes) of the City of Greater Sudbury SCADA, Controls and Instrumentation Systems Design Standards.

AC	Alternating Current
AI	Analog Input
ANSI	American National Standards Institute
AO	Analog Output
AOI	Add-on Instruction
BS	Booster Station (Water)
CAD	Computer Aided Design
CMMS	Computerized Maintenance Management System
CSA	Canadian Standards Association
DI	Discrete/Digital Input
DO	Discrete/Digital Output
DC	Direct Current
DIMM	Dual In-line Memory Module
DSL	Digital Subscriber Line
EMI	Electromagnetic Interference
ESA	Electrical Safety Authority
FAT	Factory Acceptance Test
GIS	Geographic Information System
GUI	Graphical User Interface
HART	Highway Addressable Remote Transducer
HBA	Host Bus Adapter
HDD	Hard-disk Drive
HMI	Human-Machine Interface
HSC	High Speed Counter
HVAC	Heating, Ventilation, and Air Conditioning
ICP	Instrument Control Panel
I&C	Instrumentation and Control
IEEE	Institute of Electrical & Electronics Engineers
I/O	Input/Output
IP	Internet Protocol
IPS	Intake Pumping Station (Water)
ISA	International Society of Automation
ISDN	Integrated Services Digital Network
IT	Information Technology
JB	Junction Box
LAN	Local Area Network
LCP	Local Control Panel
LS	Lift Station (Wastewater)
MOECC	Ministry of the Environment and Climate Change Ontario
MCC	Motor Control Centre

NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NIC	Network Interface Card
OIT	Operator Interface Terminal
O&M	Operations and Maintenance
OPC	Open Platform Communications, formerly known as Object Linking & Embedding (OLE) for Process Control
OS	Operating System
PC	Personal Computer
PCN	Process Control Narrative
PFD	Process Flow Diagram
P&ID	Process & Instrumentation Diagram
PAC	Programmable Automation Controller (this term is in accordance with the standard controller manufacturer's convention)
PLC	Programmable Logic Controller
PSN	Public Service Network
QA	Quality Assurance
QC	Quality Control
QPI	(Intel) Quick Path Interconnect (Link)
RAID	Redundant Array of Independent Disks
RDIMM	Registered Dual In-line Memory Module
RTU	Remote Terminal Unit
SAN	Storage Area Network
SAT	Site Acceptance Test
SCADA	Supervisory Control and Data Acquisition
SCIS	SCADA, Controls and Instrumentation Systems
SCU	System Configuration Utility
SI	System Integrator
SIM	Software Improvement Module
SNMP	Simple Network Management Protocol
SP	Service Pack
SPS	Sewage Pumping Station
STP	Sewage Treatment Plant
TCP/IP	Transmission Control Protocol/Internet Protocol
TSSA	Technical Standards and Safety Authority
UDT	User-defined Data Type
UPS	Uninterruptible Power Supply
UTP	Unshielded Twisted Pair
VLAN	Virtual Local Area Network
VPN	Virtual Private Network
WAN	Wide Area Network
WPS	Water Pumping Station
WTP	Water Treatment Plant
WWTP	Wastewater Treatment Plant

6 Governance of the Standards

6.1 Objectives and Expectations

The objective of supplying SCADA, Controls and Instrumentation Systems Design Standards is to ensure a consistent approach in design and documentation development, and standardize instrumentation, monitoring and controls, and networking products, construction, and programming, in order to optimize the cost and scope of ongoing operations and maintenance.

These Standards are intended to provide consistent guidelines for carrying out all SCADA system design and construction services. However, Consultants, Contractors and System Integrators involved in using these Standards must have the expertise in all relevant aspects of process equipment, instrumentation, SCADA, and communications, in order to provide project-specific, detailed drawings and specifications, and support construction activities, for a safe, reliable and effective engineered solution.

6.2 Standards Enforcement

Enforcement of the SCIS Design Standards is a key component of the standards management process. Unless requirements provided by the City of Greater Sudbury project assignment state specifically that a provision set forth has been waived, all provisions in this Standard, as applicable to scope of a specific assignment, are to be satisfied.

For each project, the responsibility for enforcement will be led by the City of Greater Sudbury Project Manager, with support from one common SCIS Design Standards Leader from the City of Greater Sudbury Water and Wastewater SCADA group, assigned by the City of Greater Sudbury Compliance & Operational Support Supervisor. Every project assignment issued by the City of Greater Sudbury must reference these standards documents.

6.2.1 Standards Application in Upgrades of Existing Facilities

City of Greater Sudbury's latest SCIS Design Standards must be adhered to whenever possible, including for any upgrade project design. Also, all developed standard software programming templates and standard code must be used as applicable.

6.3 Deviation Management

The standards and guidelines stipulated in this document are mandatory. It is recognized, however, that in a variety of circumstances (e.g. lack of physical space required for new control equipment, instrumentation, or process specific limitations), a deviation from the Standards may be required. As such, a party initiating the deviation must clearly identify and explain the reasons for deviation, with justification based on good engineering judgment, and bring them to the attention of the City of Greater Sudbury Project Manager. An approval to deviate from the Standards must be obtained before proceeding with the design or construction/programming work affected. The party that caused the deviation to occur without following the approvals process with the City of Greater Sudbury will be responsible for any cost and schedule impacts for re-completing the work to the Standard and will incur all costs associated with the replacement of non-standard items that were not explicitly approved by the City of Greater Sudbury.

6.3.1 Approach

A Standards Deviation Form for City of Greater Sudbury's review and acceptance is to be completed and submitted immediately after the need for deviation is identified. Refer to the Standards Deviation Form in Appendix A-1.

The Standards Deviation Form is intended to provide a template for effective identification and justification of a compliance issue, and establish a means of focusing the reviewer's efforts into that high priority item, while also serving as a tool for recording the deviations as part of the project documentation process.

7 Standards Outline

The details of standard approaches and requirements related to instrumentation and control and SCADA design, hierarchy of control, and the relationship between the SCADA and the various controller networks within the system, and between the controllers and field equipment and instrumentation, including both the software and the hardwired/networking relationships, are provided throughout the various documents that form part of this SCADA, Controls and Instrumentation Systems Design Standards Manual.

7.1 SCADA, Controls and Instrumentation Systems Design Standards Organization and Summary of Content

The City of Greater Sudbury SCADA, Controls and Instrumentation Systems Design Standards consist of several sections (A to G). Some sections have one or more appendices.

The content of the SCIS Design Standards organized by sections, major sub-sections and summaries of the topics covered, is presented in Table 1 below.

Table 1: Summary of SCADA, Controls and Instrumentation Systems Design Standards

Section	Major Sub-Sections	Executive Summary
A - General Requirements	1. Introduction 2. Document Revision Control 3. Roles and Responsibilities 4. General Instrumentation Standards and Codes 5. List of Acronyms 6. Governance of the Standards 7. Standards Outline 8. Appendices	This section provides a general introduction to a series of standard documents that form part of the City of Greater Sudbury SCADA, Controls and Instrumentation Systems Design Standards (SCIS). This section sets the guidelines for standards' application, management, and enforcement. In summary, the section covers the following: ▸ objectives and approaches ▸ change management ▸ roles and responsibilities ▸ reference to related industry standards ▸ list of commonly used acronyms ▸ standards enforcement ▸ design standards structure and sections' summaries ▸ reference to submittal requirements

Section	Major Sub-Sections	Executive Summary
B - Automation Systems Project Delivery	1. General 2. Preliminary Design 3. Detailed Design 4. System Integrator Pre-qualification 5. Vendor Equipment Packages 6. Construction 7. Site Acceptance Testing 8. System Start-up and Commissioning 9. SCADA, Controls and Instrumentation System Training 10. Contractor's O&M Manuals 11. Spare Parts Requirements 12. Trial Operation 13. Consultant's As-built Documentation 14. Warranty Services 15. Submittals 16. Appendices	This Section explains an overall project delivery process, starting from pre-design, through detailed design, construction, and hand over, as applicable to SCADA, Controls and Instrumentation systems. The main items discussed in this section are: ▸ pre-design and detailed design expectations ▸ pre-qualification of suitable SI ▸ SCIS Design Standards requirements in relation to Vendor equipment packages ▸ requirements of standard procedures conducted during construction, to be specified accordingly in the design, including but not limited to: ○ FAT and SAT hardware and software testing ○ instrumentation installation and calibration requirements ○ control loop testing requirements ○ training requirements ○ operation and maintenance manuals and documentation ○ start-up and commissioning requirements ○ spare parts and warranty requirements
C - Equipment and DataTagging	1. Introduction 2. Equipment Tagging System 3. Physical Tagging 4. Submittals 5. Appendices	This document sets up the standard tagging system for all equipment and signals, and provides tables of standard facilities, areas, equipment, and data codes that are to be used in design documentation, programming, and physical tagging
D - Instrumentation & Control Systems Design	1. Introduction 2. Process & Instrumentation Diagrams Symbols and Practices 3. Process Control Narratives 4. Approved Manufacturers and Suppliers 5. Instrumentation 6. Control Panels Design and Installation 7. Field Interface Standards 8. Field Wiring and Conduits 9. Submittals 10. Appendices	The purpose of this section is to provide guidelines and requirements for standardization of SCIS design, products and construction. The following is the summary of major items covered by this Section: ▸ P&ID purpose, scope, and standard layout ▸ P&ID standard symbols and device signals guidelines ▸ process control narrative preparation, development stages, standard template ▸ instrumentation design and installation standards, approved instrumentation products ▸ control panel layout, component wiring, cable, and installation requirements ▸ field signals and wiring, standard equipment I/O, and field I/O interfaces
E - Controller	1. Introduction 2. Controller 3. Operator Interface Terminal (OIT) 4. Submittals	The intent of this section is to specify standard controller and operator interface hardware, and set guidelines for controller programming, including reference to standard programming routines

Section	Major Sub-Sections	Executive Summary
F - Networks, Communications and Data Management	1. Introduction 2. SCADA Network Architecture 3. Local Area Networks (LAN) 4. Submittals 5. Appendices	This section provides the standard requirements and guidelines for design, expansion or upgrade of controller and SCADA infrastructure in water and wastewater facilities. In summary, it covers the following: ▸ City of Greater Sudbury SCADA network architecture including central and operations sites ▸ local area network design and integration approach and structured cabling standards and requirements ▸ network testing requirements
G - SCADA	1. Introduction 2. SCADA 3. Data Management 4. Submittals 5. Appendices	This section describes the standard requirements for SCADA hardware, software, and configuration, such as: ▸ standard SCADA architecture and hardware components ▸ SCADA development standards ▸ application configurations and settings ▸ I/O driver and communication ▸ reference to baseline application and standard routines ▸ file structure and naming ▸ security ▸ screen design, screen navigation, and standard graphics and linking ▸ alarming and trending ▸ SCADA Manual development including standard format outline of contents ▸ iHistorian and reporting ▸ data and programs backup and disaster recovery

7.2 Submittals

Appendix B-1 of the SCIS Design Standards summarizes the standard deliverables that are expected throughout a SCADA, Controls and Instrumentation project for the City of Greater Sudbury water and wastewater facilities. The summary of deliverables is organized with reference to the associated section of the SCIS Design Standards Manual, along with list of inputs that will be provided by the City of Greater Sudbury by project phase.

A-1 - Standards Deviation Request Form

A-2 - Standards Revision Request Form

A-3 - Standard Software Revision Request Form

Section B
Automation System Project Delivery

1 General

The primary intent of this Section is to provide guidelines to Consultants working on the City of Greater Sudbury water and wastewater projects involving SCADA, Controls and Instrumentation scope. These standardized guidelines summarize the expectations throughout different project stages.

The Consultants are to follow the requirements of this Section in conjunction with other Sections of the City of Greater Sudbury SCIS Design Standards when developing the design drawings and specifications, as well as while administering projects' construction. All requirements indicated in this Section as Contractor's/System Integrator's responsibility are to be clearly addressed in the specifications provided by the Consultant. All applicable document templates from these SCIS Design Standards, required to be customized for the specific scope as part of the Contractor's/System Integrator's submittals are to be properly referenced and included with the specifications.

1.1 Tagging and Master Equipment Lists

The City of Greater Sudbury has established a standard approach and procedure in dealing with equipment and data tagging. Different requirements related to tagging will be addressed throughout the design and construction stages.

The Consultant will assign the tag names to new equipment, panels, and instrumentation, and will identify any existing devices that will be removed or replaced under the scope of work. The Consultant will specifically discuss with the City of Greater Sudbury the approach to tagging of the devices to be replaced. The Consultant will also specify the requirements of physical tagging, including identifying devices that require physical tagging and specifying the types of tagging nameplates required for each device.

Based on these requirements, the Contractor will put together a tagging shop drawing submittal, listing the equipment asset tags and any additional tag nameplates that will be provided, including dimensions, text to be engraved and all other physical characteristics and sample nameplates. The Contractor will fabricate and install the required tags upon final approval of the shop drawing review.

Also, at the end of construction, the City of Greater Sudbury will receive the information from the Contractor and Contract Administrator to update their asset and maintenance data bases based on the Contractor's and Consultant's input provided through the City's Add/Delete equipment forms.

Section C – Equipment and Data Tagging explains the details of tagging structure and requirements for approval of tagging, physical tagging requirements, and updating of the City of Greater Sudbury master databases.

2 Preliminary Design

Preliminary design is the first phase of the Consultant's basic services for project design. Project design completion at the end of this phase is approximately 30%.

The first stage in the preliminary design is conceptual design, intended to map out the outline of the project. As part of this stage, alternative options, and their technical and cost-related advantages and disadvantages, and feasibility with respect to operational, maintenance, and/or space constraints are investigated, presented, and deliberated with the City of Greater Sudbury in order to establish the optimum approach in project design and delivery. Several technical memoranda covering specific topics within the project scope may be developed during this stage.

Preliminary design following the conceptual design stage is intended to provide final confirmation of the approaches and requirements related to scope of work in advance of detailed design.

A Preliminary Design Report is prepared as part of the preliminary design phase. It contains high-level design descriptions and drawings, summary of options and recommendations based on considerations of major components and associated constraints, and preliminary construction cost estimates.

2.1 SCADA, Controls and Instrumentation Systems Preliminary Design

The Preliminary Design of SCIS focuses on creating the general framework for further development of detailed requirements related to this area of the project's scope.

Whether the project is for a new facility, or an upgrade/expansion of an existing one, the key is to understand the City of Greater Sudbury's Standards for controls hardware and software, networking, instrumentation, tagging, implementation requirements, and the common operation and maintenance practices, as well as their standards for content and format of the documentation to be developed during the design and construction/implementation.

For any project within existing facilities, it is important as well to understand the condition of the existing control systems, extent of their compliance with current City of Greater Sudbury's SCIS Design Standards and evaluate potential for re-use of some of the information and practices as opposed to changing and upgrading the entire system. In that regard, a field verification of the existing control system will be completed by the Consultant on commencement of pre-design. Field verification will provide information to support proposed approaches and confirm design constructability. Iits findings will be used during detailed design to reflect the existing conditions for accurate definition of the Contractor's scope of work.

SCADA, Controls and Instrumentation Systems Preliminary Design will include:

- Field equipment verification and review of existing documentation relevant to the project's scope;
- Discussion of alternatives;
- Monitoring and control philosophy, including reference to existing infrastructure, and proposed integration with existing;
- Levels of control, and extent of automation;
- Hardware redundancy requirements;
- Software development process;
- Information management work, including, but not limited to, alarm management and reporting.

Based on the above considerations, SCIS Preliminary Design phase deliverables that also form part of SCIS section of Preliminary Design Report are:

- Field verification report;
- SCIS technical memo;
- Preliminary Device List showing device tagging;
- Preliminary SCADA network architecture drawing;
- Preliminary P&IDs;
- Preliminary construction cost estimates.

3 Detailed Design

During the detailed design development phase, the project design is further refined. Detailed definitions of all components within the scope of the project are developed. The detailed design documents describe the characteristics, configuration, and relationships of all components to be incorporated into the project.

The purpose of the detailed design phase is to finalize the documentation, such as drawings and specifications, and finalize the cost estimates for the construction of the project under the forthcoming construction contract. Finalized documents serve as a basis for contractors to obtain price quotes from subcontractors and generate their bids during tendering for the construction contract.

Generally, the detailed design is managed within several milestones, at which the technical and contract documentation is submitted for City of Greater Sudbury's review:

- 50% Detailed Design
- 75% Detailed Design
- 95% Detailed Design
- 100% Detailed Design
- Tender Package

Any deviations from these milestones, that may be applicable due to the project's size or any other circumstance related to a specific project, will be explicitly indicated in the project assignment issued by the City of Greater Sudbury.

3.1 SCADA, Controls and Instrumentation Systems Detailed Design

After the basic concepts of the control system design have been developed during the preliminary design phase, further details are specified, based on best industry practices and current integration technologies, within specific requirements of individual facilities and individual processes, and in compliance with the City of Greater Sudbury's SCIS Design Standards.

SCIS detailed design work will include, as applicable to the specific project's scope, preparation of:

- P&ID's with detailed process equipment and instrumentation I/O requirements.
- Device and I/O lists with tagging and scope of work associated (include any modification/upgrade requirements of wiring and/or programming, removal requirements, etc.).
- An instrument control panel (ICP) layout, with PAC detailed layout, typical bill of materials, and typical ICP power distribution and I/O wiring drawings, for all different types/sizes of panels.
- Network architecture drawing and campus layout drawing.
- Network field wiring layout and termination drawings.
- Plan drawings showing locations of instrumentation, ICP's, and SCADA workstations.

- A detailed operational, monitoring, and control description for each unit process, known as the Process Control Narrative (PCN). The PCN will be prepared based on the finalized Process Narrative, and in collaboration with the process engineer.

- Instrumentation and controls scope of work and components specifications.

- Specifications of testing requirements and templates of installation check sheets and hardware and software test plans.

Typical standard deliverables as part of the Detailed Design phase are as follows:

- Detailed SCADA Network Architecture Drawing and Campus Layout Drawing;

- Detailed P&IDs;

- Detailed specifications, including but not limited to:

    - Scope of work and general requirements,

    - Instrumentation and other product specifications,

    - Construction staging requirements,

    - Testing and commissioning requirements for hardware and software (FAT, SAT),

    - Contractor’s (and System Integrator’s) submittal requirements (including the FAT, SAT and commissioning plans, training and O&M manual), and training requirements;

- Equipment, instrument and I/O lists with finalized tagging, ICP sizing and PAC I/O allocations, and instrumentation requirements such as discrete instruments’ set points, analog instruments’ ranges, and performance characteristics;

- I&C wiring drawings for all typical PAC modules’ wiring, typical panel layouts and power wiring drawings;

- Detailed Process Control Narratives, including lists of alarms, set points, calculations, and any other programming variables, as well as the requirements for historical recording, trending and reporting;

- Detailed construction cost estimates.

For details of I&C design standards, controller, SCADA, network, and tagging standards, refer to corresponding Sections of the overall SCIS Design Standards Manual.

4 System Integrator Pre-Qualification

All Contractors are required to carry a System Integrator as a sub-contractor to perform all Controls Systems work for a construction Contract. The Contractors must select a pre-qualified System Integrator/System Integrators from the short list provided by the City of Greater Sudbury.

The City of Greater Sudbury will issue a request for Pre-qualification from qualified Process Control System Integrators (SI) for programming and commissioning field services for the control system component of their water and wastewater projects. The City of Greater Sudbury may complete the prequalification process on a periodic (e.g. annual) basis, and per value of integration work. or may include it in the project assignment for scope of work of the Consultant on a project, to perform the pre-qualification process for the specific project.

If a System Integrator pre-qualification is being completed for a specific project, the Consultant on the project will be responsible for preparing the prequalification request, and submitting it to the City for review, approval and issuance. The following sections provide guidelines for handling the pre-qualification process in those cases.

The pre-qualification request will, generally, identify the following:

- The City of Greater Sudbury as owner, and the Consultant on the Project.
- Background information, and the main intent and objectives of the process control system for the respective scope.
- Qualifications required from the System Integrator, such as experience with water and wastewater process control systems, and PAC, HMI, data base programming, and field commissioning.
- Submission requirements.
- General instructions to the proponents, terms and conditions.

System Integrator Pre-qualification Request document template is included in Appendix B-2. The Consultant will customize the document for the specific project. Sections that are intended for completion by the proponents will remain as per the template.

In their response to pre-qualification request, the SI companies will complete the pre-qualification form and questions included in the pre-qualification request, providing details of the proposed approach and methodology in completing the specific scope. They will also provide documentation about demonstrated overall capability and experience in specific process control fields, qualifications of the team members, proposed planning, and references from previous Clients, in accordance with the requirements of the pre-qualification request.

4.1 Submission Evaluation and Pre-qualification Guidelines

The first step in the System Integrator pre-qualification process will be an evaluation and scoring of the pre-qualification documents completed and submitted by the SI in response to the pre-qualification request. The companies short-listed as a result of this evaluation may be called for an interview, and those chosen following the interview will be carried as acceptable SI teams in the construction tender documents.

In summary, the following steps will be completed as part of the Consultant's and the City of Greater Sudbury's collaborative effort in this pre-qualification process:

1. Scoring of pre-qualification submissions.
2. Short listing 3-6 SI to be invited for an interview.
3. Interviewing of the short-listed SI.
4. Finalizing the list of at least two pre-qualified SI.

Further guidelines related to the above phases of SI pre-qualification have been prepared to assist the project staff as provided in the following sections. These are preliminary guidelines and evaluation criteria to be used to score and rank the System Integrators' responses. Prior to conducting the pre-qualification for any specific project, this evaluation and scoring system will be reviewed and adjusted as required in accordance with the specific scope and expectations.

4.1.1 Scoring and Preliminary Short-listing

1. Corporate and Financial Information (Maximum 5 points)

A. Evaluate information provided in terms of completeness

Suggested criteria for assessing the submission:

- Is the response complete?
- Is any further history on the firm e.g. mergers, acquisitions, restructuring required for completeness of information?
- Is any more information on nature and extent of business operations required?
- Are the values of system integration projects the proponent completed in the past comparable with the value of the project of the pre-qualification request?
- From the information provided, is there any issue or concern that would suggest the proponent might have difficulty undertaking the work?

Guidelines for scoring:

- Partially responds to the request – up to 2.5 points
- Generally satisfies the request – 3-4 points
- Fully responds to the request – 5 points

2. System Expertise (Maximum 30 points)

A. Evaluate information provided in terms of completeness and assess the degree to which projects are consistent with requirements of the pre-qualification request (Suggested Maximum 15).

Suggested criteria for assessing the submission:

- Is the response complete?
- Was the number of relevant projects completed in the past 5 years less than three?
- From the information provided and previous projects experiences, is there any issue or concern that would suggest the proponent might have difficulty undertaking the work?

Guidelines for scoring:

- Only partially meets request and expectations – up to 5 points
- Generally meets request and expectations – 9-13 points
- Fully satisfies request and expectations – 15 points

B. Conduct reference checks and assess in terms of past/present performance and expectations of success in completing all requirements (suggested Maximum 15)

Reference checks will be made without limitation and including obtaining feedback from reference contact persons.

Suggested criteria for assessing the submission:

- Health and safety practices, any workplace accident history
- Performance in regards to:
  - Project scheduling, timelines and budget
  - Quality of workmanship/service
  - Scope changes
  - Deficiencies
- Claims history
- Outstanding liens
- Any comments with respect to proponent's staff in relation to performance of work, attitude, knowledge, communications, documentation etc.

Guidelines for scoring:

- Only partially meets expectations of success in completing our requirements – up to 5 points
- Generally meets expectations of success in completing our requirements – 9-13 points
- Fully meets expectations of success in completing our requirements – 15 points

3. Project and Staffing Information (Maximum 40 points)

A. Evaluate information on office personnel provided in terms of completeness and assess expected ability to support the successful completion of the work (Suggested Maximum 20 points)

Suggested criteria for assessing the submission:

- Is the proposed staff's expertise relevant to this contract?
- Is the proposed project manager experienced in managing a project of this size, type and complexity?
- Is there any issue with the proponent's team size and/or any team member's qualification/experience?

Guidelines for scoring:

- Only partially meets request and expectations – up to 10 points
- Generally meets request and expectations – 14-18 points
- Fully meets request and expectations –20 points

B. Evaluate information on onsite personnel provided in terms of completeness and assess expected ability to support the successful conclusion of the work (Suggested Maximum 20 points)

Suggested criteria for assessing the submission:

- Is there any issue with the on-site team size and organization?
- What are the credentials of the proposed on-site staff, and how do they relate to the specific scope and complexity of work to be undertaken?
- What contingency plans does the proponent have in place to ensure continuity in the event of staff changes?

Guidelines for scoring:

- Only partially meets request and expectations – up to 10 points
- Generally meets request and expectations – 14-18 points
- Fully meets request and expectations –20 points

4. Supplementary Information Specific to the Proposed Works (Maximum points 25)

Assess the supplementary information in terms of its relevance to the City of Greater Sudbury SCIS standards and the specific project's scope, and in terms of the proponent's capability to successfully complete the proposed work.

Suggested criteria for assessing the submission:

- SCIS equipment availability for in-house development and testing
- SCIS software/licensing availability for in-house development and testing
- Ability to develop submittals and testing documentation
- Warranties
- Emergency response times
- Maintenance and support – Help desk 24/7
- Manuals

Guidelines for scoring:

- Only partially meets expectations of success in completing the requirements of the pre-qualification request – up to 13 points
- Generally meets expectations of success in completing the requirements of the pre-qualification request – 18-22 points
- Fully meets expectations of success in completing the requirements of the pre-qualification request – 25 points

5. Any additional information provided by the Proponent that may be taken into consideration as part of any of the above but not specifically requested

Provide an explanation in terms of how evaluator reflected any additional information provided by the proponent in 1-4 above (if applicable).

4.1.2 Discussions with Proponents

Depending on the need, complexity, and scope of work, interviews may be conducted with proponents to support the evaluation process. In general terms, the discussions will be related to the following:

- Procedures for effectively scheduling and co-coordinating the work
- Health and safety practices
- Understanding of the City of Greater Sudbury SCIS standards
- Approach that will be taken by the proponent in conducting the work
- Approach in documentation development
- Method of communications between office and site staff
- Approach to addressing deficiencies
- Time frame for completion of outstanding deficiencies after achieving Substantial Completion certification

4.1.3 Pre-qualification Matrix for Individual Proponents

The following is a suggested form for summarizing the evaluation results for individual proponents:

Pre-qualification Request #:	**Date:**	
Proponent's Name:		
Criteria	**Maximum Points Obtainable**	**Actual Points Awarded**
Corporate and Financial Information	5	
System Expertise	30	
Project and Staffing Information	40	
Supplementary Information	25	
Total points Awarded	100	
Minimum number of points required (if applicable)	(Specify)	(Specify if Meets minimum / Does not meet minimum)
Minimum/maximum number of vendors to be selected (if applicable)	(Specify)	
Pre-qualified (Included in short list)	**(Specify Yes / No)**	**Ranking:**
Rated by:	**Date:**	

5 Vendor Equipment Packages

For specialized process applications such as chemical dosing, compressed air, blowers, centrifuges, boilers, etc., equipment vendors typically offer pre-packaged systems which may be equipped with PLCs/PACs and operator interfaces. Depending on the type of equipment, and length of time required for its fabrication and delivery, the pre-packaged equipment may be specified as part of the main construction contract for a project, or a pre-selection/pre-purchase process is conducted in advance of tendering for the main construction contract. In either case, detailed construction specifications for the Vendor package must be prepared by the Consultant.

The specification defining requirements for Vendor pre-packaged equipment controls and instrumentation will clearly include all necessary considerations related to full conformance with City of Greater Sudbury's SCADA, Controls and Instrumentation System Design Standards, including, but not limited to tagging, control system hardware and software, submittals, integration, and testing and commissioning. Any potential deviation from this compliance will be processed through the standardized deviation approval request, as per Section A - General Requirements, prior to becoming part of the specifications.

Therefore, in addition to requirements developed in co-ordination with process, mechanical and electrical disciplines, the Consultant's instrumentation and controls portion of specifications for Vendor's scope of supply will include the following, as applicable:

- Instrumentation requirements with respect to City of Greater Sudbury's Standards.
- Control panel requirements with respect to City of Greater Sudbury's Standards for ICP's, i.e. control panel layout and wiring requirements, PAC and other panel hardware requirements, panel construction, testing, FAT, installation requirements, and panel drawings, and construction and installation testing and check off documentation requirements.
- PAC/OIT programming requirements in compliance with City of Greater Sudbury Standards.
- List of all facility systems that will interface with the packaged system and/or are affected by the packaged system, spreadsheet of data to be exchanged, and method of data exchange.
- Networking requirements and communications protocols.
- Scope of SCADA integration, including database, graphics, alarms, and other aspects required from the Vendor for the related System Integrator's SCADA development.
- Software testing, Site Acceptance Testing and commissioning requirements, including identification of dependencies on other facility systems, and co-ordination with System Integrator.
- Requirements for construction staging meetings/workshops for finalized integration plan and co-ordination of scheduling.
- Training requirements including a preliminary outline of the type and duration of training.
- Requirements for the provision of O&M manuals including software documentation.

Note that the City of Greater Sudbury's preferred approach in Vendor package integration is to tie Vendor's I/O and programming into a main process PAC, as opposed to having the Vendor supply a PAC as part of their package. The Consultant will enforce this preferred approach when discussing the design with the Vendors, and when developing the Vendor package specifications.

If, however, a PAC and OIT are being supplied as part of Vendor package, all Vendor programming and PAC/OIT hardware will be fully compliant with the City of Greater Sudbury's Standards. The City of Greater Sudbury will not accept any proprietary or generic programming that may be part of the Vendor's templates, but only programming that is compliant with the City of Greater Sudbury's Standards, and, that is eventually handed over to the City unlocked for maintenance and troubleshooting purposes.

A template for the Vendor Equipment Package SCIS specification for Consultants is provided in Appendix B-3.

6 Construction

6.1 Co-ordination during Construction

During the construction stage, the Consultant generally takes a Contract Administrator role and in that role would be responsible for construction supervision, review and administration of construction documentation such as requests for information, shop drawing submittals, equipment installation check sheets, testing documents and reports, etc., attending the FAT/SAT/Commissioning, preparation of deficiency lists, scheduling and conducting of training sessions, support for Contractor's training, and for all related co-ordination with the City of Greater Sudbury's staff, and between the Contractor and the City of Greater Sudbury's staff, primarily with the City's Project Manager and the facility Operations.

Different phases of the construction staging and their related requirements specific to SCIS are explained in the following sections. For overview of the phasing, refer to the flow charts in Appendix B-9.

6.2 Shop Drawings

The Contractor is to submit shop drawings for all equipment, instrumentation, panels, and programming from the scope of the contract in compliance with the City of Greater Sudbury's Standards. The procurement/fabrication and installation will proceed only upon review of the corresponding shop drawings.

The Contract Administrator is responsible for review of the shop drawings in accordance with the Contract documents. The City of Greater Sudbury may review and provide comments on the shop drawings submittals as well.

6.3 Factory Acceptance Testing

The Factory Acceptance Test (FAT) demonstrates that all SCADA and controller hardware and software are working correctly, and that the control panel and other hardware components and wiring, as well as software configuration and programming, comply with the design requirements, as reflected in the detailed hardware and software specifications, design drawings and process control narratives.

6.3.1 Control System Hardware FAT

The purpose of the hardware FAT is to ensure the integrity of the system used in control and monitoring. This FAT is intended to demonstrate that the system configuration will function effectively, such that the need for any modifications upon installation on site is minimized.

The Contractor (panel builder) must ensure that the ICP and any components to be installed as part of the control hardware for the project (controllers, workstations and workstation enclosures, etc.), are fully inspected and pre-tested prior to scheduling a witnessed FAT. Signed off internal check sheets, along with a thorough FAT plan will then be submitted to the Contract Administrator and the City of Greater Sudbury for review.

The witnessed FAT session(s) will be scheduled with the Contract Administrator and the City of Greater Sudbury's representatives. The FAT plan submittal for review will be provided by the Contractor no later than two (2) weeks prior to the intended start of FAT.

6.3.1.1 Control Panel FAT

Include all provisions necessary for the panel inspection and FAT to be conducted in an environment that simulates actual operating conditions. Following are guidelines to be specified for the Contractor for preparation of, and conducting of a control panel FAT:

- Panel visual inspection and verification of compliance with panel as-built drawings - panel enclosure inspection, verification of size, classification/rating, quality of construction, verification of components installed and of their identification, verification of all controller and, as applicable, OIT hardware.
- Verification of panel power distribution and related components such as circuit breakers, fuses, DC power supplies.
- Verification of wiring - point to point continuity, terminations, wiring tagging.
- Verification of grounding and bonding - confirm that grounding conductor is installed, and that its DC resistance is below specified maximum.
- Verification of the controller I/O:
  - Configure controller with a suitable “dummy” program, establish connection and communication with the FAT user interface (operator interface terminal/workstation/laptop).
  - Any discrete inputs from pushbuttons/selector switches located at the immediate panel will be directly energized from the corresponding panel devices, and the discrete inputs from all field devices will be tested with the use of a suitable input simulator. As required, temporarily wire digital inputs to test switches.
  - Any analog inputs from panel-mounted components such as potentiometers will be tested from the actual signal source; all others will be tested by using an appropriate analog signal generator.
  - Discrete outputs are to be simulated in the HMI or from the PAC I/O table, depending on the specific system configuration. Any outputs energizing panel-mounted devices such as lights or annunciators will be checked with the actual end devices. Outputs to field devices will be demonstrated by use of temporary wiring of the respective field terminals in the panel to a multi-meter or to an external indication light.
  - Analog outputs are to be simulated from the software interface. Any outputs energizing panel-mounted indicators will be checked with the actual end devices. Analog outputs to field devices will be demonstrated by temporarily wiring them to external analog indicators.

The FAT plan will also be developed by the Contractor based on the above guidelines with all I/O listed by type, and with details related to addressing, signal levels, analog signal ranges, and with space for check-off and comments to be filled in during the FAT. Methods and equipment to be used for completing individual sections of the FAT plan will also be explained in the document. The document will be provided with the FAT sign-off sheet, and with space for a comment/issue log.

The Consultant will also refer to the template in Appendix B-4 and include it when developing a detailed specification of the requirements for the Contractor’s panel FAT. Specify to the Contractor that the FAT plan must be customized for a specific panel, for specific component functions, tag names and ratings (e.g. circuit breakers, fuses, relays), and for specific PAC I/O.

All deficiencies identified during the FAT will be addressed, corrected and verified/confirmed before shipment of equipment to site.

6.3.1.2 Panel Hardware FAT Submittals

The following submittals must be made to the Contract Administrator and the City of Greater Sudbury:

- Panel FAT plan and as-built drawings.
- Completed Panel FAT plan with associated comments upon execution of the FAT.
- Deficiencies List, complete with schedule for completion of items included. The deficiencies are required to be completed prior to shipment of the panel to site.
- FAT Sign-Off form indicating acceptance of completion of the tests.

6.3.2 Control System Software FAT

All software will be thoroughly tested with the intent to anticipate all possible normal process conditions, and as many as possible abnormal process conditions, to prove that the software developed satisfies the scope of work and has no defects. A wide range of operating scenarios, with all process set points, interlocks and alarm limits will be tested.

The purpose of the software FAT is to provide a witnessed demonstration of the SCADA system programming, to show that it meets the plant operational requirements and that, once on site, it will perform as expected according to the Process Control Narrative. Coordination during the scheduling of the software FAT will determine if the FAT will take place at the System Integrator's office or at the City of Greater Sudbury's office, however, the software FAT is to be conducted local to the City of Greater Sudbury's area. Both the Contract Administrator's and the City of Greater Sudbury's representative will be invited to attend and witness the software FAT.

The FAT must follow a documented test plan, prepared by the System Integrator, and reviewed by Contract Administrator and the City of Greater Sudbury prior to scheduling of the FAT. All present at the FAT will be issued a copy of the reviewed FAT plan and checklist.

All software and devices are to be setup to simulate the final system onsite, i.e. the hardware used for setting up the FAT environment is to be equal to the hardware that will be installed in the field. Intended hardware setup for FAT environment will be included in the FAT plan.

As well, method and interface intended to be used for physical I/O simulation during the FAT will be clearly established and explained in the FAT plan (e.g. use of PAC I/O tables for I/O testing and custom simulation logic in PAC to force equipment feedback for auto logic demonstration, or use of specialized simulation software programs).

As part of the FAT plan development, the System Integrator will prepare the lists/tables of I/O points, interlocks, alarms, set points, and customize the I/O and Software Variables Checklist as per the template in Appendix B-6. The Consultant will include this template as part of the detailed specification of the System Integrator's software FAT requirements.

The Consultant's specification will also require the System Integrator to customize the overall FAT plan document as per the template provided in Appendix B-5. A section of the FAT plan will be developed to document the auto logic testing. Test cases will be elaborated for devices and/or groups of devices, starting from the cases that will demonstrate normal operation, and continuing through the cases where abnormal/interlock conditions are present. Each condition in the process narrative must be demonstrated to be working. The test cases will be presented in the following format:

- Intent of the test
- Initial Condition
- Action
- Expected Result

The FAT plan will be submitted for review, along with pre-FAT software programming, no later than three (3) weeks prior to the tentative start of FAT. The System Integrator will incorporate any required modifications from the Contract Administrator's and the City of Greater Sudbury's review into the pre-FAT programming test plan/checklist in advance of the start of FAT. The FAT schedule will be confirmed at the time the System Integrator receives the pre-FAT submittal review comments.

6.3.2.1 Control System Software FAT Submittals

The following will be specified by the Consultant to form part of System Integrator's pre-FAT submittal that must be made to the Contract Administrator and the City of Greater Sudbury, as part of witnessed software pre-FAT submittal:

- Electronic copy of pre-FAT version of software (PAC, OIT, SCADA - as applicable to the scope);
- SCADA (and OIT, as applicable) screen shots;
- Software FAT Plan complete with auto logic and variables' check sheets.

The following will form part of post-FAT submittal that must be made to the Contract Administrator and the City of Greater Sudbury within one (1) week upon completion of the FAT:

- Report of executed FAT, with FAT Plan check sheets completed and any deficiencies noted;
- FAT Sign-off Form, identifying all parties involved in execution and witnessing of the SAT;
- Electronic copies of all FAT-ed software (including any changes to the pre-FAT version made during the FAT);
- Updated Process Control Narrative.

6.4 Instrument Installation and Calibration

The Contractor will supply all materials, equipment, documentation, and labour necessary for installation, calibration and verification of instrumentation prior to SAT, start-up and commissioning, as specified by the Consultant.

The work will be carried out by qualified technicians, including the Manufacturer's representative for services during installation and calibration as specified. All applicable safety measures must be taken, and proper safety equipment must be used for confined space entry and in other hazardous locations.

A calibration schedule, including any (existing) process shut-down requirements, and installation check list, including instrument installation and calibration procedures and forms are to be provided for each instrument.

The Consultant will include the templates provided in Appendix B-8 as part of detailed specification of the instrumentation installation, calibration and testing requirements, with the requirement to the Contractor to customize these templates for the specific scope and instruments.

The forms completed by the Contractor during instrument installation checks, as well as instrument field calibration reports are to be certified by the Manufacturer's representative and submitted to the Contract Administrator along with as-built product data sheets, for review prior to scheduling a witnessed field verification for instrument acceptance.

7 Site Acceptance Testing

7.1 Verification of Panel Installation

Once the Contractor's work on panel installation and related conduits and wiring has been completed, panel pre-start-up verification will be scheduled by the Contractor, to be witnessed by the Contract Administrator. Typical items to check will be panel location with respect to other equipment in the area, field wiring and conduits, field wiring inside the panel, panel nameplates, absence of any damage to the panel and maintained panel rating during delivery and installation, and panel as-built drawings.

Panel Installation check form, as per Appendix B-7, will be used to record the completion of the checks. Any issues identified must be corrected and re-checked in order to obtain the Contract Administrator's sign off.

The Consultant will include the template provided in Appendix B-7 as part of detailed specification of the instrumentation installation, calibration and testing requirements, with the requirement to the Contractor to customize the template to include references to the specific panels provided under the scope.

7.2 Verification of Instrument Installation and Calibration

The field instrument acceptance verification will be performed by the Contractor and witnessed by the Contract Administrator. The checks will confirm that the field instruments' components and functionality are per product data sheets reviewed through shop drawing review, and that the instruments are installed in accordance with the requirements of the contract and ISA guidelines. For example, arrangement of components, adequacy of process connections and wiring, conduit installation, power supply, provision of local disconnect switch, grounding, calibration range and other relevant settings, local display, as well as absence of any damage to the instrument during delivery and installation, will be verified.

Instruments that are found to be defective or incorrectly calibrated will immediately be rejected. Issues identified must be rectified, and the test must be repeated.

Upon witnessing a satisfactory demonstration of instrument installation and functionality, the Contract Administrator will sign off the Instrument Installation and Calibration Checklist, and review the Calibration Forms provided by the Contractor based on specified requirements and templates from Appendix B-8.

7.3 Field Wiring and Control Loop Verification

All wiring provided by the Contractor will be checked for conformance to the latest revision of the Canadian Electrical Code and to the Electrical Area Classification for Hazardous Locations where applicable.

All ICP internal power wiring, as well as instrument power wiring from ICP, and PAC I/O signal wiring will be checked for installation, continuity, correct polarity and correct tagging.

A complete internal (not witnessed by the Contract Administrator or City of Greater Sudbury) loop check is to be performed, including source and destination. Each loop will be checked based on exercising the actual field devices, and verifying the expected result. All loop checks must be documented and submitted to the Contract Administrator for acceptance prior to commencing commissioning activities.

Following completion of internal loop checks, the Contractor will arrange with the electrical, and instrumentation and control Sub-contractor and System Integrator for testing of loop wiring between local control and starter/actuator panels, PAC panels, and instruments and field devices, and advise the Contract Administrator and the City of Greater Sudbury to be present to witness the procedure.

When testing equipment and instrumentation signal loops, the results will be evaluated on a pass/fail basis. The Contractor is required to perform the testing of the full loop - from/to the field device/panel, to check the functionality of the instrument/device as well as the field wiring back to the ICP. The testing will be performed in a logical sequence and in groups of tests. If more than two items within a group fail the loop checkout, the entire group will be deemed to have failed the checkout. If three or more deficient groups occur, the Contractor will be requested to repeat all pre-commissioning checks.

Issues identified during the loop checks must be rectified. Once the problem is resolved, check sheets will be resubmitted, revised as required, and the entire group test must be repeated.

Signal Loop check sheets will be developed and submitted to the Contract Administrator and the City of Greater Sudbury for review no later than two (2) weeks in advance of the SAT. The Contract Administrator will witness the final I/O loop checks. Refer to I/O spreadsheet in Appendix B-6, to be used as the SAT Signal Testing Check Sheet template.

Upon witnessing satisfactory loop checks, the Contract Administrator will sign off the SAT Signal Testing Check Sheets. The equipment, instrumentation and control system will then be considered ready for testing as part of control software Site Acceptance Testing.

7.4 Software Site Acceptance Testing (SAT)

The purpose of the software SAT is to validate the full implementation of the system and programmed control philosophies. The SAT is similar to the FAT, except that it is performed on-site to demonstrate the operation of the actual equipment under PAC/SCADA control, upon installation of instrumentation, equipment, control hardware, and wiring, and upon completion of the System Integrator's software pre-SAT.

A SAT plan will be developed and submitted with the pre-SAT version of programmed software, to the Contract Administrator and the City of Greater Sudbury for review no later than three (3) weeks in advance of the intended SAT date.

The SAT plan will be a modified version of the FAT plan, but will include all actual devices, and start and stop sequences and operation as a whole system. SAT requires field devices to be operated, i.e. instrument and equipment, and any miscellaneous device I/O to be exercised in the field, in order to verify the monitoring and control functions and loops from source elements to OIT/SCADA display. As applicable, actions such as manipulating discrete instruments like float switches, operating hand-off-auto switches and local control panel push buttons, equipment local and control panels' and MCC starters' power disconnect switches, activating PAC outputs and verifying the equipment feedback, will be performed as part of the SAT. Therefore, the SAT plan will also identify any safety or process-related measures, any requirements for support from the Contractor's staff, and any other special requirements and procedures for performing the intended tests.

FAT plan templates provided in Appendix B-5 and Appendix B-6 will be generally followed in preparation of the SAT documents, customized specific to the SAT environment, as per the above considerations.

The SAT will be witnessed by representatives of the Contract Administrator and the City of Greater Sudbury. All present at the SAT will receive a copy of the reviewed SAT plan and checklist for recording test results.

If any issues are identified, they are to be logged on the deficiencies list, to be addressed by the Contractor and/or System Integrator, as applicable. The SAT sign off will occur after the SAT deficiencies have been addressed and successfully retested. At that point, the Start-up and Commissioning stage of the project may begin.

7.4.1.1 Control System Software SAT Submittals

The following pre-SAT submittals must be specified by the Consultant to be made by the System Integrator to the Contract Administrator and the City of Greater Sudbury, for review prior to scheduling of the witnessed software SAT:

- Electronic copy of pre-SAT version of software (PAC, OIT, SCADA – as applicable to the scope), with all FAT deficiencies addressed, and with all configuration parameters updated for the actual SAT condition;
- SCADA (and OIT, as applicable) screen shots, with all FAT deficiencies addressed;
- Software SAT Plan complete with auto logic and variables' check sheets.
- List of SAT pre-requisites, as required to coordinate and conduct the SAT activities.

The following will form part of the post-SAT submittal that must be made to the Contract Administrator and the City of Greater Sudbury within one (1) week upon completion of the software SAT:

- Report of executed SAT, with SAT Plan check sheets completed and any deficiencies noted;
- SAT Deficiencies List;
- SAT Sign-off Form, identifying all parties involved in execution and witnessing of the SAT;
- Electronic copies of all SAT-ed software (including any changes made to the pre-SAT version during the SAT);
- Updated Process Control Narrative.

8 System Start-up and Commissioning

The intent of system start-up and commissioning phase is to provide an opportunity for final verification of installation and functionality of all the components to the requirements specified, before the system is handed over to the City of Greater Sudbury.

System start-up and commissioning typically coincides with the beginning of the facility test period, the duration of which is specified in the Contract documents. During this period, the system is operated under different process loads and conditions, and primarily in automatic modes of software operation, to emulate, as practically as possible, a normal operation of the system.

The system start-up and commissioning plan will be prepared by the Contractor, outlining the following:

- Roles and responsibilities;
- List of pre-requisites that are to be completed and checked before starting the commissioning;
- Schedule of start-up and commissioning activities;
- Start-up and commissioning procedure;
- Start-up and commissioning checklist.

Generally, SCADA, Controls and Instrumentation system commissioning activities include the following:

- Field instrument verification;
- Configuration of communications equipment;
- Verification of all communication I/O and software interlocks/controls based on exchange of I/O between controllers;
- Finalization of all initial set points, hardcoded set points, control loop tuning parameters, verification of totalized/calculated values;
- Integration of the system into an existing SCADA system, including connection to databases, reporting and alarm systems, or other interface applications;

The City of Greater Sudbury has developed a Standard Operating Procedure (SOP) for commissioning. All the commissioning and start-up requirements for the Contractor specified by the Consultant on any project will be aligned with the City of Greater Sudbury's commissioning SOP. The pre-commissioning and commissioning flow chart from this SOP is included in Appendix B-9. As required, the full SOP can be requested by the Consultant from the City of Greater Sudbury's Project Manager.

9 SCADA, Controls and Instrumentation Systems Training

Both the Consultant and the Contractor will provide SCADA training to the City of Greater Sudbury's operation and maintenance staff. The Consultant, in the role of Contract Administrator will also attend and support the Contractor's training sessions.

The training schedule will be formally submitted to the City of Greater Sudbury for co-ordination with the availability of the City of Greater Sudbury's staff. The training sessions are to be provided in multiple instances, to accommodate staff working shifts, and also to ensure relevant training information is supplied in sufficient detail to operations and maintenance groups respectively.

Generally, separate training sessions are required for operations and maintenance staff respectively. Specific requirements related to number, duration and organization of training sessions will be included in the Project Assignment. The details of requirements for the Contractor's training will be included in the Consultant's specifications that will form part of the construction Contract documents. For general guidelines, refer to Training page of the flow chart in Appendix B-9.

9.1 Training Provided by Consultant

Overall, the training provided by the Consultant is to overview the project scope, application of process devices, instrumentation, controls and SCADA system for the facility/process(es) affected by the scope.

The Consultant will prepare a Training Plan, which will be submitted for the City of Greater Sudbury's review and approval. Generally, the following topics will be included in the Training Plan:

- Introduction:
  - Project scope review, review of controls works provided.
  - PAC/SCADA development process.
  - Reference to documentation/Operation and Maintenance Manuals (e.g. P&ID drawings, PAC panel drawings, instrument/panel location and layout drawings).
- Process Overview:
  - Process control narrative review; control philosophy, control hierarchy.
  - Hardwired and software interlocks, alarms, and safety during equipment Remote-Automatic operation.
- Review of SCADA System:
  - System overall architecture and components,
  - Tagging definitions,
  - Operation from different control levels,
  - SCADA system security,
  - Troubleshooting scenarios.

9.2 Training Provided by Contractor

The training provided by the Contractor is to explain the specific instrumentation, hardware components, and software programming provided under the Contract.

The Training Manual and training schedule prepared by Contractor and their Sub-contractors, including the System Integrator, will be issued to the Contract Administrator and the City of Greater Sudbury for review and acceptance.

Training by the Contractor, specific to SCADA, Controls and Instrumentation part of the scope will, generally, include the following:

- Information about-SCIS Hardware:
  - Instruments by type and application,
  - ICP panels and locations, PAC and HMI hardware components,
  - Network hardware and locations,
  - PAC and HMI programming information,
  - Operator interface (explanation of OIT/SCADA displays, navigation, equipment monitoring and control functions, alarm monitoring, process set points adjustment, etc.),
  - Troubleshooting scenarios.
- Preventative Maintenance Functions, explained in detail to Maintenance staff, and complemented with field hands-on instruction:
  - Control hardware details of installation/replacement, maintenance, and troubleshooting,
  - Control panel locations,
  - Control panel and field control wiring information,
  - Instrumentation locations, instrument hardware, installation, calibration, and maintenance and troubleshooting information,
  - Network cabling and terminations information, network equipment locations, and network hardware troubleshooting information,
  - Safety procedures during maintenance/repair activities.

10 Operation and Maintenance Manuals

The Operation and Maintenance (O&M) Manual will be prepared in two separate documents, Operation Manual, and Maintenance Manual, which may be further divided in volumes as required and will be configured as per the City of Greater Sudbury Operation and Maintenance Manual Standards

10.1 Operations Manual

Operation Manual prepared by Consultant will consist of the following major sections:

- Introduction
- Facility Overview
- Unit Operations and Control

The Unit Operations and Control section will be divided into subsections, based on process/sub-process and equipment affected. As applicable, the specific subsections will include start-up and shutdown sequences, normal operation, failure response and troubleshooting, with reference to related SCADA screens and applicable operator's interventions.

The manual will include appropriate pictures and graphics to support the information and instructions provided, as well as relevant tabular information, such as process/equipment capacities, performance parameters, compliance requirements and targets.

As a guideline, the following Appendices will be provided:

- Applicable licenses and permits
- Standard Operating Procedures and forms
- Emergency contacts
- Applicable standards and regulations
- Contingency plan
- First Engineers' Report recommendations

10.2 Maintenance Manual

The Consultant's specifications for construction Contract documents will include the details of requirements for preparation of the SCIS Equipment Maintenance Manuals, for the process control system hardware and software provided under the Contractor's scope.

The Contractor will prepare and organize the operation, maintenance and test data, including all relevant installation, maintenance and troubleshooting documentation from the hardware suppliers and manufacturers, signed off test forms and installation check sheets, and will coordinate with the System Integrator for the preparation of software manuals.

The Maintenance Manual's table of contents will be based on the specifications' section numbers.

Specific to SCADA, Controls and Instrumentation scope/section, Contractor's Equipment Maintenance Manuals, will, generally, include the following sub-sections:

- Instrumentation Manual - Provide the following information for each model/ piece of equipment and instrument:
  - Manufacturer's design and performance specification data and descriptive literature showing dimensions, installation requirements, typical mounting details, list of required and optional accessories, recommended spare parts, electrical/pneumatic signal and power connection diagrams, inspection and preventive maintenance requirements, and warranty requirements;
  - Instrument Data Sheets, including instrument tag, description, complete model number, range, set point, construction material, etc. prepared based on format in ISA Standard -S20: Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves;
  - Signed instrument installation and calibration check-off sheets, including list of parameters as configured.
- Instrument Control Panel System Hardware Manual, including the following information:
  - Manufacturer's literature providing the component's functional and hardware description, configuration parameters setup (e.g. for instrumentation, VFD's, etc.) troubleshooting information, requirements for periodic inspection, cleaning, and other preventive maintenance activities, removal and replacement instructions;
  - Wiring and schematic diagrams for maintenance and troubleshooting of electric and controls circuits;
  - Signed control loop wiring check sheets;
  - Instrument Control Panel as-built drawings and installation check off sheets.
- Hardware and Software Configuration Manual, including all information on the system set-up including hardware, software and network. It generally contains the following information:
  - Overview of the plant-wide and project-specific PAC and SCADA network configuration and equipment information:
    - Hardware configuration (PAC, SCADA servers and workstations, etc.),
    - Network components/levels and communication interfaces;
    - Network architecture drawings, campus layout drawing, and network hardware bill of material,
  - Details all of the system configuration parameters, such as controller configurations, racks, I/O modules and I/O assignment, spare I/O;
  - Controller memory allocation;
  - PAC messaging information.
  - SCADA data base configuration, SCADA access and security, historical data configuration.

- SCIS Operation and Software User's Manual is intended to provide operators with step-by-step instructions for monitoring and controlling the SCADA system. All of the functions of the user interface are to be described in detail in the Operations section. Troubleshooting tips will also be provided. The following is the summary of the content of the Operations section of the SCADA Manual:
  - SCADA and OIT screen display summary, and description of individual displays, including pop-ups;
  - Reference to related project drawings and P&ID's.
  - Display structure and navigation description, user access levels information;
  - Display functionality, operator's functions achievable from each display;
  - Control set points and other programmed variables;
  - Process controls' normal operation, failure operation; troubleshooting tips
  - Review of SCADA operations and functions common to all process areas, such as:
    - Alarm management;
    - Historical recording;
    - Trends;
    - System Security and administration.
  - As-built version of the Process Control Narrative.
- Contract as-built (red-lined) drawings

10.3 Manual Structure

A Table of Contents will be created by the Consultant/Contractor for the Operation Manual and Maintenance Manual, for the specific project's scope, in accordance with these guidelines, and will be submitted for review by Contract Administrator and the City of Greater Sudbury, prior to the actual Manuals' preparation/submittal. The City of Greater Sudbury's Table of Contents for a sample Operation Manual, and sample Maintenance Manual from the most recent Operation and Maintenance Standards may be requested from the Contract Administrator/City of Greater Sudbury for further guidance.

All sections/subsections/tables/figures/appendices will be electronically book-marked and linked to the table of contents/list of tables/figures. In hard copies of the manuals, separators with tabs will be provided respectively, for easy reference.

For guidelines on Contractor's manuals' submittal schedule, refer to Manuals page of the flow chart in Appendix B-9,

11 SCIS Inventories and Spare Parts Requirements

The Consultant will identify all requirements for critical spare parts with the City of Greater Sudbury Project Team during the detailed design, and will specify them accordingly. Spare parts will be supplied by the Contractor as per specifications in the contract documents and as per manufacturer's recommendations, including quantities, delivery, and storage requirements.

The Consultant's specification will include a requirement to the Contractor to complete and submit an as-built inventory spreadsheet for all SCIS equipment/parts supplied under the scope of work of the project. The spreadsheet template with examples is included in Appendix B-10. Only parts with "active" status, meaning currently available on the market from their original Manufacturers and not intended to be discontinued by the Manufacturer, are to be specified in the Consultant's design. Any changes to the status of any affected standard parts during the course of the project will be brought up to the City of Greater Sudbury's attention.

12 Trial Operation

The purpose of the trial run operation is to test the overall system performance over a period of time and confirm it satisfies the design criteria. The duration of the trial operation period is to be specified by the Consultant.

For general guideline, refer to Start-up and commissioning page of the flow chart in Appendix B-9.

During the performance run period, the system is operated by the City of Greater Sudbury's (Facility's) Operations personnel, as normal day-to-day operations. Within the duration of this period, some abnormal operational conditions may be verified as well.

Any deficiencies identified by the City of Greater Sudbury's Operations personnel during this time are to be documented and provided to the Contract Administrator for review and inclusion in the deficiency list, which will be issued to the Contractor to address the issues. The Contract Administrator will maintain the master deficiency list and track addressing of the issues. Based on the status of items in this list, it will be identified and decided when the project has reached the substantial completion stage.

The Consultant will specify in the Contract documents that not addressing the deficiencies could hold the Contractor up from getting paid their deficiency holdback. The Contract will specify an itemized deficiency holdback which would be applied, and will define holdback amount relative to value of deficiency, and the terms and conditions for issuance of notification to the Contractor for the defective work.

After the trial operation phase is completed, and the City of Greater Sudbury is satisfied with the performance of the overall system, and the status of the deficiency list, the City of Greater Sudbury will issue a Certificate of Substantial Completion. At that moment, the system warranty period will start.

13 Consultant’s As-Built Documentation

The construction mark-ups are made by the construction Contractor to reflect the changes made to the original design during the construction stage. As-built drawings and process control narratives are prepared by the Consultant by updating the original design documents based on construction mark-ups and System Integrator’s updates. The as-built documentation is submitted to the City of Greater Sudbury at the end of the project.

14 Warranty Services

The Warranty period will be specified in the Contract documents. Generally, it is a 2 year period starting from the date of substantial completion of construction. Within this time, through the warranty process, the Contractor will respond when contacted to resolve any hardware/software product and/or installation deficiencies associated with the project's scope, as encountered during the regular facility operations and maintenance activities.

Close to the expiration of the warranty period, the City of Greater Sudbury, Contract Administrator, and Contractor and System Integrator will meet on site for a final field review. Any identified deficiencies will be documented and processed as part of the final warranty claim. Upon the Contractor successfully addressing all of the deficiencies, the Project close-out and sign-off will take place.

The Contract will include the requirements for the Contractor to provide a schedule of supplied and installed product warranties, with corresponding start dates and durations, as the City of Greater Sudbury must know if those product warranties expire before the end of the overall Contract warranty period.

15 Submittals

Appendix B-1, Matrix of Design Phases and Required Deliverables, summarizes the standard deliverables that are expected throughout a SCADA, Controls and Instrumentation System project for the City of Greater Sudbury water and wastewater facilities. The summary of deliverables is organized by parties responsible for providing and for receiving the deliverables, and by project phase. Also, a reference to the associated section of the SCIS Design Standards, and a list of inputs that will be provided by the City of Greater Sudbury are included.

B-1 – Matrix of Design Phases and Required Deliverables

B-2 – Control Systems Integrator Pre-selection Document Template

B-3 – Vendor Package SCADA, Controls and Instrumentation Specification Template

B-4 – Panel Hardware FAT Plan Template

B-5 – Control System Software FAT Plan Template

B-6 – Software FAT Variables Checklist

B-7 – Panel Installation Check Sheet

B-8 – Instrument Installation and Calibration Checklist

B-9 – City of Greater Sudbury Commissioning Flow Chart

B-10 – Controller and Instrumentation Inventory Sheets

Section C

Equipment and Data Tagging

1 Introduction

This document describes the tagging system for all equipment and signals, for tagging on Process Instrumentation Diagrams (P&ID), process control system network architecture drawings, instrumentation and controls layout drawings, mechanical and electrical drawings, Process Control Narratives, process flow diagrams, and in PAC, HMI and other water and wastewater software programming in the City of Greater Sudbury. Subsequently, the tagging based on this standard will be reflected in the City of Greater Sudbury's asset inventory lists and asset and maintenance management data bases, as well as on the physical tag nameplates attached to the equipment in the field.

The purpose of the Equipment and Data Tagging standard is to provide consistency in equipment and instrument labeling across the City of Greater Sudbury's water and wastewater facilities. This standard is intended to:

- enable efficient management of asset related database records,
- establish the approach to equipment physical tagging and identification,
- reduce time for troubleshooting PAC and SCADA software code,
- facilitate cross-referencing among devices in the field and associated software programming, drawings and other related documentation.

The standardized tagging system will require a unique name (tag) for each piece of equipment, device I/O signal, PAC and SCADA software generated signal or data. This will enhance data management within the City of Greater Sudbury work management system, and facilitate scheduling of maintenance and/or replacement of the equipment.

The physical location of the equipment (Site ID) is identified as part of the tag name, by the facility name abbreviation, and by the process area / facility type abbreviation, which both form part of the tag name. The standard tagging structure is explained in more detail further in this document.

This document is part of a series of standards and, as such, should not be viewed in isolation of other Sections of the City of Greater Sudbury SCIS Design Standards. Associated standards may modify and/or clarify the requirements set forth within this document.

1.1 Application of Tagging Standard

This standard is intended to provide the City of Greater Sudbury with a coding system to be applied to projects related to their water and wastewater facilities.

The Consultants on new and upgrade projects for the City of Greater Sudbury water and wastewater facilities will follow this standard's guidelines for developing equipment tag names, and for the requirements of physical tagging.

The tagging system established in the Consultant's design documentation will be further applied during construction, and will also be used by the Contractor and System Integrator when preparing and submitting shop drawings, programming, Operation Manuals and Maintenance Manuals, and other documentation developed during the construction phase of the project.

Eventually, the tagging system will be used to prepare equipment lists for the City of Greater Sudbury to correlate between SCADA and the Geographic Information System (GIS) platform for equipment location identification and the City Works Computerized Maintenance Management System (CMMS), allowing maintenance work orders to be correctly attributed to the equipment and allow for engineering analysis to be conducted utilizing historical process data information extracted from the SCADA system.

The design Consultant will utilize the coding system to clearly identify all equipment in the equipment schedules, and on the Process Flow Diagrams (PFD) and Process and Instrumentation Diagrams (P&ID), regardless of whether the equipment is connected to the SCADA control system or not.

The tagging system is to be applied to the following equipment:

- Process-Mechanical
- Instrumentation
- SCADA
- Electrical
- HVAC

1.2 Scope of the Tagging Standard and Related Forms and Procedures

Equipment, equipment loops, data and local area network devices will be tagged in accordance with this Standard.

1.2.1 Tagging Approval

It is essential that uniqueness be provided and the proper tag structure followed. The Consultant will prepare and submit the proposed tagging for the City of Greater Sudbury approval to ensure compliance with the standards, and avoid tag duplications. Generally, the tag name lists may be required for the following categories of the equipment, depending on the scope, i.e. depending on whether the project is for a new facility, or is a refurbishment project (i.e. involving new, upgraded, and/or deleted assets).

- New equipment.
- Equipment that is going to be replaced or upgraded, retaining the same process function.
- Equipment to be removed under the project's scope.

1.2.2 Add and Delete Equipment Forms

City of Greater Sudbury's Add and Delete Equipment forms will be provided to be used for the tagging approval process and as a summary of required modifications to the City's asset management and maintenance management systems.

- Consultant is to request the Add and Delete Equipment forms from the City of Greater Sudbury's Project Manager.
- Consultant is to complete the tag name assignments for any new equipment, as well as to list items for deletion and/or revision as part of the project scope.
- These forms will be issued to the City of Greater Sudbury for approval of the proposed asset tagging. Any changes to the assigned tagging throughout the design will be specifically sent for City's approval.
- Any intent to reuse the existing tags in either the same (for equipment being replaced) or different capacity (reusing the tag of a device that will be permanently deleted) will need to be discussed

with the City of Greater Sudbury at the very beginning of the preliminary design stage, as the City may prefer to assign brand new tags.

- Add/Delete forms will be included in the Consultant's design specifications with the scope and instructions for the construction Contractor to further edit the forms for the specific equipment supplied, to include complete parts list with numbers, manufacturer and contact information.

- During construction, Contractor is required to coordinate Add/Equipment Forms with the Contract Administrator and the City through shop drawing submittal and review process. All relevant fields for each item provided within the equipment inventory file will be completed by the Contractor, including all maintenance information applicable. The Contractor will transfer manufacturer's recommended preventative maintenance tasks and frequencies into the spreadsheet. In case existing equipment tags are being reused for the replacement/upgrade equipment, all associated information must be updated, to properly reflect the new equipment.

- The completeness/acceptance of the Contractor's submittal will be a prerequisite to equipment and systems commissioning.

- After construction is completed, finalized forms will be submitted to the City for final update of their asset and maintenance management data bases.

For a sample add equipment and maintenance information spreadsheet, refer to Appendix C-1.

1.2.3 Showing Tags on Drawings and Design Documentation

Since, typically, all devices within a single P&ID or single I/O card loop wiring diagram belong to the same facility, and sometimes to the same process, individual device/signal tags on those drawings can omit the first and, as applicable, the second fragment of the code; however, in those cases a note on the drawing is required to identify the common part of the tag names (i.e. the facility, and as required, the process code that apply).

The first code fragment can also be omitted in the PAC programming as long as the program name and the comments in the program code provide clear identification of the facility. The tag name fragments will never be omitted in the SCADA database tagging or in the physical tagging.

1.2.4 Update of Tagging Standard

This standard covers most processes, equipment, instruments and combinations thereof. Extensive use of existing industry standards such as IEEE and ISA has been made throughout this guideline document. However, when there is introduction of new processes, equipment, instrument and control signals, which are not listed in this standard, a common sense approach will prevail to name and tag the new item.

The new codes proposed will be unique. The party requesting the addition/change to any of the lists of standard codes included in this Standard will notify the City of Greater Sudbury for approval of the new code, and for updating of this standard, following the Standards Revision process established in Section A - General Requirements.

No codes are to be used that are not identified in this document without prior approval from the City of Greater Sudbury. The City must be fully aware of, and approve all new codes to be used in a project as well as approve any deviations from the standard, thus allowing the Standards document to be updated on a continuous basis.

1.3 Application to Design and Construction Documentation

The tagging system is to be applied by the design Consultant at the start of the conceptual or preliminary design phase of the project. Codes are to be used in the following documents:

- Equipment Add/Delete Forms
- Process Flow Diagram (PFD)
- Process & Instrumentation Diagram (P&ID)
- Process Control Narrative (PCN)
- Preliminary Design Report
- Design Report
- Detailed Design Drawings (including loop drawings and control schematics)
- O&M Manuals

The design Consultant is to include in the contract specifications the requirements for the Contractor and System Integrator to use the assigned tagging when developing their documentation and programming for the contract scope. The Consultant will also specify the requirement for the Contractor to fabricate the correct physical tags for equipment, instrumentation, control panels, and will identify the devices requiring a physical tag.

During the design phase of the project, the design Consultant is to submit to the City of Greater Sudbury a complete listing of all equipment tags and signals proposed for the project for approval, as explained in Section 1.2 of this document. All projects and contracts are to follow the most current version of this standard, as provided by the City of Greater Sudbury at the beginning of the project, through to the conclusion of the project.

To ensure a consistent implementation of this standard, all questions, comments and submissions for review that are covered under this standard are to be issued to the City of Greater Sudbury's Water and Wastewater Services Compliance and Operational Support Supervisor and SCIS Design Standards Leader for the project.

1.4 Abbreviations

The standard tagging structure established through this Standard is based on abbreviations which are used for coding of different fragments of the tag names. Sections within this document identify how the coding system is to be applied.

2 Equipment Tagging System

In all City of Greater Sudbury systems, unique identifiers are required for each piece of equipment, device and instrument, along with unique identifiers for monitoring and control signals and data in the PAC/SCADA system.

Unique identifiers are constructed from multiple ‘fragments’, each of which has a pre-defined purpose, to provide the following information:

- Location within a regional scheme, i.e. facility identification,
- Process area within a defined facility,
- Device type,
- Device number or loop identifier,
- Device I/O signals and data type within the PAC/SCADA system.

2.1 Tagname Convention

The tagging code consists of fragments made of alphanumeric combinations of characters, as per following structure:

Table 2: Tagname Structure

	Site ID		Device Type	Loop Number	SCADA Code
	Facility Code	Site Type /			
Fragment	**1**	**2**	**3**	**4**	**5**
Format	**AAA(N)**	**–AAA**	**–AAAA**	**–NNNN**	**_AAACC**
No. of Characters	**1 - 4**	**2 - 3**	**1 - 4**	**4**	**1 - 6**

Where, A Denotes Alphabetic Character (letter A-Z)

N Denotes Numeric Character (number 0 - 9)

C Denotes alphanumeric character (either alphabetic or numeric)

The fragments denoted by the numbers 1 to 5 in Table 2 above have the following definitions:

Fragment 1 is a one to three character alphabetic code representing the facility name, i.e. WAN for Wanapitei Water Treatment Plant. The fourth numeric character may be added as an exception, however only in a case where two or more remote facilities have the same name, i.e. the same first three characters, and are of the same type, thus also having the same second fragment. Approved Facility Codes are shown in Table 3.

Fragment 2 is a two or three character alphabetic code representing the type of a remote facility or a process/sub-process within the larger facility, such as water treatment plant, i.e. TRW = Treated Water, FL = Fluoridation. Approved Process Area Codes are shown in Table 4.

Fragment 3 is a one to four character alphabetic code representing the type of equipment or instrument (the equipment or device description code), i.e. SC = screen, FIT = flow indicating transmitter, G = sluice gate. Approved Device Type Codes are shown in Table 7 for equipment and Table 8 for instruments.

Fragment 4 is a four-character numeric code representing the device/loop number.

Fragment 5 is a one to six character alphanumeric code for I/O Data/SCADA Signals (only the last two characters are allowed to be numeric). This fragment may contain an underscore instead of one of the characters within the allowed length of the fragment (e.g. KQ_RST). Approved SCADA Signal Codes are shown in Table 11 with approved abbreviations that can be used for any new SCADA Signal Codes shown in Table 12.

2.2 Fragment Identification

2.2.1 Fragment 1 (Facility Code)

Each Site within the City of Greater Sudbury Water and Wastewater System is uniquely identified by a combination of two fragments. The first fragment is a one to three character long alphabetic code, based on abbreviation of the facility name. Two or more sites may have the same facility code; however Fragment 1 and Fragment 2 used in conjunction provide unique identification – Site ID – for each site within the City of Greater Sudbury Water and Wastewater system. Standard codes for the first fragment of the Site ID and therefore the first fragment of the equipment tag names are listed in Table 3 below. List of Site ID’s for all existing sites is provided in Table 6 in Section 2.2.2 where Standard codes for Fragment 2 are also discussed.

Table 3: Facility Code (Facility Name Abbreviation)

Fragment 1	Facility
ACC	Access South End Rock Tunnel
ALG	Algonquin Booster
AND	Anderson Lift Station
AZI	(1) Azilda Wastewater Treatment Plant (2) Azilda Water Tank
BAN	(1) Bancroft Bulk Water (2) Bank Rock Tunnel
BAY	Bay Street Bulk Water
BEL	Belanger Lift Station
BEV	Beverly Lift Station
BLA	Black Lake Bulk Water
BOU	Bouchard South End Rock Tunnel
BRE	Brenda Drive Lift Station
BRO	Brookside Lift Station
BUR	Burwash South End Rock Tunnel
CAP	Capreol M and J Wells
CAS	Caswell South End Rock Tunnel
CEN	Centennial Booster
CER	Cerilli Lift Station
CHA	Charette Lift Station
CHE	(1) Chelmsford Wastewater Treatment Plant (2) Chelmsford Water Tank (3) Chenier Well (Q-Well)
CON	(1) Coniston Metering Station (2) Coniston Wastewater Treatment Plant
COP	Copper Park Booster
COU	(1) Countryside Bulk Water (2) Countryside Lift Station
CRA	Craig Mine Water Tank
DAV	David Street Water Treatment Plant
DES	Deschene Well
DON	Don Lita Lift Station
DOW	(1) Dowling Wastewater Treatment Plant (2) Dowling Water Tank

Fragment 1	Facility
DUF	Dufferin Lift Station
EDW	Edward Lift Station
ELL	Ellis Reservoir
EST	Ester Lift Station
FAL	(1) Falconbridge Water Tank (2) Falconbridge Wells
FLE	Fleming Lift Station
FOU	Fourth Avenue Lift Station
FRA	Fraser Lift Station
FRO	(1) Bulk Water (2) Frobisher Frost Well
GAR	Gar-Con Lift Station
GAR1	Garson Wells #1 & #3
GAR2	Garson Well #2 (Old Inco #1)
HAR	Hardy Fluoride
HAZ	Hazel Lift Station
HEL	Helene Lift Station
HIL	Hillsdale Lift Station
HLP	Helen’s Point Lift Station
I	Capreol I-Well
JAC	Jacob Lift Station
JEA	Jeanne D’Arc Lift Station
JOG	Jogues Booster
KEN	Kenneth Well
KIN	Kincora Lift Station
LAG	Lagace Lift Station
LAK	Lakeview Lift Station
LAN	Landry Lift Station
LAU	Laurier Lift Station
LEV	(1) Levack Wastewater Treatment Plant (2) Levesque Lift Station
LIN	Linden Well
LIO	Lionel Well
LIV	(1) Lively Metering Station (2) Lively Valve Chamber (3) Lively Wastewater Treatment Plant
LLO	Lloyd Lift Station
LOA	Loach’s Road Lift Station
MAD	Madeleine Lift Station
MAG	(1) Magill Lift Station (2) Magill Metering Station
MAI	Main Lift Station
MAL	Maley Booster
MAP	Maple Street Lift Station
MAR	Marier Lift Station
MCN	McNaughton Rock Tunnel
MIC	Michelle Well
MNB	Moonlight Beach Lift Station
MOO	Moonlight Lift Station
MOT	Mott Booster
MRC	Marcel Bouchard Lift Station
MRK	Mark Lift Station
NAU	Naughton Metering Station

Fragment 1	Facility
NIC	Nickel Lift Station
NOR	Northshore Lift Station
NOT	Notre Dame Well
OJA	Oja Lift Station
ONA	(1) Onaping Pressure Control Facility (2) Onaping Water Tank (3) Onaping Wells
ONE	(1) O'Neil Lift Station (2) O'Neil Valve
ORF	Orford Street Lift Station
ORI	Oriole South End Rock Tunnel
PEN	Penman Lift Station
PHA	Pharand Well
PHI	Philippe Well
PRI	Principale Lift Station
R	R-Well
RAD	Radisson Lift Station
RAM	Ramsey Lift Station
RAY	(1) Rayside Bulk Water (2) Rayside Depot
RIV	(1) Riverside Lift Station (2) Riverside Well
SEL	Selkirk Lift Station
SHE	Sherwood Lift Station
SIE	Simon East Lift Station
SIW	Simon West Lift Station
SLU	Sludge Transfer Lift Station
SNO	Snowdon Booster
SOU	Southview Lift Station
SPR	(1) Spruce Bulk Water (2) Spruce Lift Station
STC	(1) St. Clair Bulk Water (2) St. Charles Lift Station
STI	(1) Stinson Metering Station (2) St. Isidore Lift Station
SUD	Sudbury Wastewater Treatment Plant
SUE	Suez Bulk Water
SUN	Sunrise Ridge Booster
TEN	Tena Lift Station
TUP	Tupper Lift Station
VAG	Vagnini Lift Station
VAL	(1) Val Caron Booster (2) Val Caron Water Tank
VER	Vermillion Lift Station
VLE	Valley East Wastewater Treatment Plant
WAL	(1) Walden Wastewater Treatment Plant (2) Walden Water Tank (3) Walford East Lift Station (4) Walmart Valve PLC
WAN	(1) Wanapitei Water Treatment Plant (2) Wanapitei Intake
WIT	Whitson Lift Station
YOR	York Lift Station

All Equipment within the physical boundary (i.e. property line) of a water or wastewater facility will have a common facility code.

2.2.2 Fragment 2 (Process Area Code)

This fragment identifies process or type of facility which a device belongs to. For remote facilities, the second fragment of the Site ID identifying facility type is also used as the second fragment of the equipment tag names at that facility, For Water and Wastewater Plants, in the equipment tag names the second fragment identifying facility type (WTP/WW) is substituted with specific process area code.

Standard codes for the second fragment of the Site ID and second fragment of the equipment tag names are listed in Table 4 below. An example of process area code breakdown for a plant and associated remote site is provided in Table 5, and a list of facilities with their Site IDs is provided in Table 6.

Table 4: Process Area / Facility Type Code

Fragment 2	Meaning
AC	Air Conditioning, Heating and Ventilation
AD	Admin Building
AER	Aeration Tanks and Diffuser System
ALM	Alum
AM	Ammoniation
AST	Ash Thickening and Handling System
ATM	Atmosphere Monitoring
AUX	Auxiliary System
BLD	Building (Used for Fire/Intrusion/Etc.)
BPS	Booster Pumping Station
BT	Biosolids Treatment
BW	Back Wash System
CBW	Commercial Bulk Water
CG	Co-Generation
CHM	Chemical (Generic)
CLA	Pre-chlorination
CLB	Post-chlorination
CLC	Trim-chlorination
CSO	Combined Sewers Overflow
CWS	City Water System
DCL	De-chlorination
DEP	Depot
DIG	Digestion
DIS	Disinfection (Chlorination and UV System)
DRW	Dry Well
DST	Distribution (Local Distribution - Electrical)
DW	Dewatering
ELS	Shops Electrical / Instrumentation
EN	Energy Facility (Generator / Elec. Sub Station)
EPS	Effluent Pumping System
ET	Elevated Water Storage Tank
EWS	Effluent Water System
FL	Fluoridation
FLO	Flocculation

Fragment 2	Meaning
FLT	Filtration
GAC	Granular Activated Carbon
GR	Grit Removal
GRK	Grounds Keeping
HAD	HVAC System - Administration Building
HBL	HVAC System - Blower Building
HC	HVAC System - Central Service Area
HDE	HVAC System - Disinfection and Effluent Pumping Building
HDG	HVAC System - Digestion Building
HDW	HVAC System - Dewatering Building
HHW	HVAC System - Headworks Building
HIN	HVAC System - Incineration Building
HOC	HVAC System - Odour Control Building
HP	HVAC System - Primary Service Area
HRS	HVAC System - Raw Sewage Pumping Station
HS	HVAC System - Secondary Service Area
HW	Headworks (including screening)
IAS	Instrument Air System
IN	Incineration
IPS	Intake Pumping Station
ITS	Information Technology Systems
LIM	Lime
LS	Lift Station (Wastewater)
MC	Metering Chamber / Station
MCS	Shops Mechanical / Welding
ML	Mixed Liquor
OC	Odour Control
OCF	Remote Odour Control Facility
PA	Process Air System (Aeration Blowers and Accessories)
PAC	Powder Activated Carbon
PCF	Pressure Control Facility
PCL	Polyaluminum Chloride
PDG	Primary Digestion
POL	Polymer
PPH	Polyphosphate
PRM	Primary Treatment / Primary Clarification
PRS	Phosphorus Removal System
RAS	Return Activated Sludge
RBW	Residential Bulk Water
RES	Remote Reservoir
RM	Residue Management

Fragment 2	Meaning
RSP	Raw Sewage Pumping
RT	Rock Tunnel
RW	Raw Water
SA	Service Air (Non Instrument or Process)
SDG	Secondary Digestion
SED	Sedimentation
SL	Sludge
SLD	Sludge Drying
SLO	Sludge Loading Station
SM	Spill Management
SMP	System Monitoring Points
SPC	System Process Control
STR	Secondary Treatment / Secondary Clarification
THK	Sludge Thickening
TRW	Treated Water
VEH	Vehicles
VC	Valve Chamber
WAS	Waste Activated Sludge
WCP	Water Circulation Program
WEL	Fresh Water Well
WEW	Wet Well
WPS	Water Pumping Station
WTP	Water Treatment
WW	Wastewater Treatment
ZMC	Zebra Mussel Control

At the beginning of the pre-design stage, the Consultant will develop a detailed breakdown of the process area codes for the facility they are designing. This suggested breakdown will be discussed with the City of Greater Sudbury for their agreement and approval before any detailed tagging for the project is started.

Vendor Packaged systems (membranes, odour control, polymer, etc.) may be assigned as individual process areas, or as part of the major process area. The Consultant will recommend the approach based on size and function of the packaged system, and confirm with the City of Greater Sudbury during the detailed design. For example, the same polymer storage system may be used for both the sludge thickening area and the sludge dewatering area of a wastewater treatment plant; tin such a case, it would be adequate to assign the polymer process area code to the package equipment. If the system were associated with, for example, dewatering area only, it would be assigned the main (dewatering) process area code. Where multiple packaged systems are assigned as part of a common process area, and as part of an overall effort to achieve uniqueness of tagging, the Consultant must ensure that tagname assignments are not duplicated amongst vendors.

Table 5 provides an example of the detailed breakdown of the process area codes for Wanapitei Water Treatment Plant.

Table 5: Process Area/Remote Facility Assignment Example for Wanapitei WTP

Facility	Process Area (Fragment 2)	Description
WAN (Wanapitei) - Intake Pumping Station	IPS	Intake Pumping Station
WAN (Wanapitei) - Water Treatment Plant	SED	Sedimentation and Sludge Pumping
	DIS	Chlorine/Chlorinators
	LIM	Lime
	ALM	Alum
	POL	Polymer
	FL	Fluoridation
	PPH	Polyphosphate
	FLT	Filters, Back Wash Pumps, Wash Water
	TRW	Treated Water - High Lift/UV
	EN	Energy Facility - Generator
	DST	Local Electrical Distribution
	AUX	Auxiliary System
Remote Facility – RES (Reservoir)	ELL	Ellis Reservoir

List of City of Greater Sudbury Site IDs, consisting of Facility name and Site type abbreviations is provided in Table 6.

Table 6: City of Greater Sudbury Site IDs

Site ID	Site Name
	WATER TREATMENT PLANTS
DAV_WTP	David Street Water Treatment Plant
WAN_WTP	Wanapitei Water Treatment Plant
	REMOTE WATER SITES
ALG_BPS	Algonquin Booster Station
AZI_ET	Azilda Water Tank
CAP_WEL	Capreol M & J Wells
CEN_BPS	Centennial Booster Station
CHE_ET	Chelmsford Water Tank
CHE_WEL	Chenier Well (Q-Well)
CON_MC	Coniston Metering Station
COP_BPS	Copper Park Booster Station
CRA_ET	Craig Mine Water Tank
DES_WEL	Deschene Well
DOW_ET	Dowling Water Tank
ELL_RES	Ellis Reservoir
FAL_ET	Falconbridge Water Tank
FAL_WEL	Falconbridge Wells
FRO_WEL	Frost Well

Site ID	Site Name
GAR1_WEL	Garson Wells #1 & #3
GAR2_WEL	Garson Well #2 (OLD INCO #1)
HAR_FL	Hardy Fluoride
I_WEL	Capreol I-Well
JOG_BPS	Jogues Booster Station
KEN_WEL	Kenneth Well
LIN_WEL	Linden Well
LIO_WEL	Lionel Well
LIV_MC	Lively Metering Station
LIV_VC	Lively Valve Chamber
MAG_MC	Magill Metering Station
MAL_BPS	Maley Booster Station
MIC_WEL	Michelle Well
MOT_BPS	Mott Booster Station
NAU_MC	Naughton Metering Station
NOT_WEL	Notre Dame Well
ONA_ET	Onaping Water Tank
ONA_PCF	Onaping Pressure Control Facility
ONA_WEL	Onaping Wells
ONE_VC	O'Neil Valve
PHA_WEL	Pharand Well
PHI_WEL	Philippe Well
RAY_DEP	Rayside Depot
RIV_WEL	Riverside Well
R_WEL	R-Well
SNO_BPS	Snowdon Booster Station
STI_MC	Stinson Metering Station
SUN_BPS	Sunrise Ridge Booster Station
VAL_BPS	Val Caron Booster Station
VAL_ET	Val Caron Water Tank
WAL_ET	Walden Water Tank
WAN_IPS	Wanapitei Intake Pumping Station
	BULK WATER FILLING STATIONS
BAN_RBW	Bancroft Bulk Water
BAY_RBW	Bay Street Bulk Water
BLA_CBW	Black Lake Bulk Water
COU_RBW	Countryside Bulk Water
FRO_CBW	Frobisher Bulk Water
RAY_CBW	Rayside Bulk Water
SPR_RBW	Spruce Bulk Water
STC_CBW	St. Clair Bulk Water
SUE_CBW	Suez Bulk Water
	WASTEWATER TREATMENT PLANTS
AZI_WW	Azilda Wastewater Treatment Plant
CHE_WW	Chelmsford Wastewater Treatment Plant

Site ID	Site Name
CON_WW	Coniston Wastewater Treatment Plant
DOW_WW	Dowling Wastewater Treatment Plant
LEV_WW	Levack Wastewater Treatment Plant
LIV_WW	Lively Wastewater Treatment Plant
SUD_WW	Sudbury Wastewater Treatment Plant
VLE_WW	Valley East Wastewater Treatment Plant
WAL_WW	Walden Wastewater Treatment Plant
	WASTEWATER LIFT STATIONS
AND_LS	Anderson Lift Station
BEL_LS	Belanger Lift Station
BEV_LS	Beverly Lift Station
BRE_LS	Brenda Drive Lift Station
BRO_LS	Brookside Lift Station
CER_LS	Cerilli Lift Station
CHA_LS	Charette Lift Station
COU_LS	Countryside Lift Station
DON_LS	Don Lita Lift Station
DUF_LS	Dufferin Lift Station
EDW_LS	Edward Lift Station
EST_LS	Ester Lift Station
FLE_LS	Fleming Lift Station
FOU_LS	Fourth Avenue Lift Station
FRA_LS	Fraser Lift Station
GAR_LS	Gar-Con Lift Station
HAZ_LS	Hazel Lift Station
HEL_LS	Helene Lift Station
HIL_LS	Hillsdale Lift Station
HLP_LS	Helen's Point Lift Station
JAC_LS	Jacob Lift Station
JEA_LS	Jeanne D'Arc Lift Station
KIN_LS	Kincora Lift Station
LAG_LS	Lagace Lift Station
LAK_LS	Lakeview Lift Station
LAN_LS	Landry Lift Station
LAU_LS	Laurier Lift Station
LEV_LS	Levesque Lift Station
LLO_LS	Lloyd Lift Station
LOA_LS	Loach's Road Lift Station
MAD_LS	Madeleine Lift Station
MAG_LS	Magill Lift Station
MAI_LS	Main Lift Station
MAP_LS	Maple Street Lift Station
MAR_LS	Marier Lift Station
MNB_LS	Moonlight Beach Lift Station
MOO_LS	Moonlight Lift Station

Site ID	Site Name
MRC_LS	Marcel Bouchard Lift Station
MRK_LS	Mark Lift Station
NIC_LS	Nickel Lift Station
NOR_LS	Northshore Lift Station
OJA_LS	Oja Lift Station
ONE_LS	O'Neil Lift Station
ORF_LS	Orford Street Lift Station
PEN_LS	Penman Lift Station
PRI_LS	Principale Lift Station
RAD_LS	Radisson Lift Station
RAM_LS	Ramsey Lift Station
RIV_LS	Riverside Lift Station
SEL_LS	Selkirk Lift Station
SHE_LS	Sherwood Lift Station
SIE_LS	Simon East Lift Station
SIW_LS	Simon West Lift Station
SLU_LS	Sludge Transfer Lift Station
SOU_LS	Southview Lift Station
SPR_LS	Spruce Lift Station
STC_LS	St. Charles Lift Station
STI_LS	St. Isidore Lift Station
TEN_LS	Tena Lift Station
TUP_LS	Tupper Lift Station
VAG_LS	Vagnini Lift Station
VER_LS	Vermillion Lift Station
WAL_LS	Walford East Lift Station
WIT_LS	Whitson Lift Station
YOR_LS	York Lift Station
	ROCK TUNNEL SITES
ACC_RT	Access South End Rock Tunnel
BAN_RT	Bank Rock Tunnel
BOU_RT	Bouchard South End Rock Tunnel
BUR_RT	Burwash South End Rock Tunnel
CAS_RT	Caswell South End Rock Tunnel
MCN_RT	McNaughton Rock Tunnel
ORI_RT	Oriole South End Rock Tunnel
WAL_VC	Walmart Valve PLC

2.2.3 Fragment 3 (Device Type Code)

Standard device type codes are provided in Table 7 and Table 8, for equipment and instrument codes respectively.

2.2.3.1 Equipment Codes

Table 7: Device Type Code - Equipment

Fragment 3	Equipment Description
AAD	Alarm Auto Dialer
AC	Air Conditioning Unit
AF	Anaerobic Filter
AHU	Air Handling Unit
AM	Atmosphere Monitoring
ANL	Analyzer
ART	Air Receiver Tank
BAT	Battery
BFP	Backflow Preventer
BL	Blower
BO	Boiler
BOX	Box
BRC	Breaching
BT	Blending Tank
BU	Burner
C	Compressor
CAP	Capacitor
CB	Circuit Breaker
CC	Cross Collector
CF	Centrifuge
CH	Chamber
CHL	Chlorinator
CI	Chiller
CL	Classifier
CLR	Clarifier
CM	Collector Mechanism
CMP	Compactor
CNV	Conveyor Equipment
COM	Communications Equipment
CP	Control Panel
CPU	Computer
CT	Controller, Temperature
CU	Condensing Unit
CUS	Chemical Unloading Station
CYC	Cyclone, Vortex
D	Air Dryer / Dehumidifier
DA	Deaerator
DCS	Diffuser Cleaning System
DD	Display Device (Data Panel Monitor)
DM	Damper, Louvre
DPM	Digital Power Monitor
DRA	Door Alarm (Intrusion Alarm)

Fragment 3	Equipment Description
DRV	Drive Electric, Mechanical
DU	Ducting
ELV	Elevator
ENG	Engine
EV	Evaporator
EWS	Eye Wash/Shower Station
F	Filter
FA	Fire Alarm System
FBR	Fluidized Bed Reactor
FBX	Fibre Box Panel
FD	Feeder, Chemical
FDE	Feeder Electrical (Includes Bus bars of any Voltage)
FEQ	Fire related Equipment
FN	Fan
FP	Filter Press
FU	Furnace
FX	Flame Arrestor
G	Sluice Gate
GB	Gas Booster Station
GD	Gas Detection System
GDR	Grinder, Comminutor
GEN	Generator
GM	Gas Monitoring System
GR	Gear Box
HE	Heat Exchanger
HTR	Heater
HU	Humidifier
ICH	Network Switch
ICP	Instrument Control Panel
LAG	Lagoon
LB	Load Breaker
LBS	Load Break Switch
LCP	Local Control Panel
LCS	Local Control Station (Push Button Station)
LD	Lifting Device
LG	Level Gauge
LP	Lighting Panel
LTG	Lighting
M	Motor
MCC	Motor Control Centre
MCP	Master Control Panel
MX	Mixer, Flocculator and Agitator
OIT	Operator Interface Terminal
OT	Oil Tank
OTF	Outfall Structure
OZ	Ozonator

Fragment 3	Equipment Description
[XX]P	Pump, where [XX] is the process flow identification based on the first 2 letters of the project flow identification stream as identified by the Flow Stream Identification Table included in this section. Examples are listed below: GRP - Grit Pump HLP - High Lift Pump IP - Intake Pump MP - Chemical Metering (dosing) Pump RSP - Raw Sewage Pump PSP - Primary Sludge Pump RAP - Return Activated Sludge Pump SMP - Sump Pump SPP - Sampling Pump WAP - Waste Activated Sludge Pump
PA	Public Address System
PAC	Programmable Automation Controller
PD	Primary Digester
PDP	Power Distribution Panel
PLC	Programmable Logic Controller
PMP	Pump (Generic)
PRT	Printer
PS	Power Supply
QUEN	Quencher
R	Reactor
RC	Recorder
RES	Reservoir
RIO	Remote IO Unit
RST	Rotating Skimmer Trough
SB	Scrubber
SCAM	Security Camera System (Motion Detection)
SCAN	Security System Scanner
SCR	Screen / Trash Rack
SD	Secondary Digester
SERV	Server
SMP	Sump
SO	Sulphonator
SP	Sampler / Sampling Point
SS	Sanitary Sump
ST	Starter
STR	Strainer
SWG	Switchgear
SIL	Silencer
T	Tank / Vessel
TB	Tie Breaker
TR	Transformer
UPS	Uninterruptible Power Supply

Fragment 3	Equipment Description
UV	Ultra-Violet Reactor
[XX]V	Valve, where [XX] is specific to the valve operating principle. Examples are listed below: SV - Solenoid Valve MV - Motorized Valve PV - Pneumatic Valve CV - Check Valve HV - Hand Valve ARV - Air Release Valve
VENT	Vent
WEL	Well
WSC	Weigh Scale Station

Equipment tags are to be assigned for the whole equipment assembly. For example, only one equipment code is to be created for an assembly comprising pump; motor, gearbox, and other integral components of the pump. Also, a single equipment tag is to be assigned for a valve and its actuator, instrument sensor and transmitter, etc.

2.2.3.2 Instrument Codes

Primary element and local indicator codes in the Table 8 below are not intended for use on physical identification tags of the field devices. They are included in the table for use as required for identification in P&ID Drawings, instrument location drawings, specifications and other related documentation.

Primary elements (sensors), even where they are installed remotely from the transmitter, are considered an integral part of the instrument, and are to be tagged in the field according to the overall instrument tag name, which is assigned based on analyzer/transmitter identification code.

Table 8: Device Type Code - Instrument

Fragment 3	Instrument/Signal Description
AE	Analyzer Element
AIT	Analysis Indicating Transmitter
ART	Analysis Recording Transmitter
ASH	Analysis Switch High
ASL	Analysis Switch Low
EC	Potentiometer
EIT	Voltage Indicating Transmitter
ERT	Voltage Recording Transmitter
FE	Flow Element
FI	Flow Indicator or Gauge
FIC	Flow Indicating Controller
FIT	Flow Indicating Transmitter
FQ	Flow Totalizing Meter
FQIR	Flow Totalizing Indicating Recorder
FRT	Flow Recording Transmitter
FS	Flow Switch
FSH	Flow Switch High
FSL	Flow Switch Low
HMS	Hand Momentary Switch (or Pushbutton)

Fragment 3	Instrument/Signal Description
HS	Hand Switch
IIT	Current Indicating Transmitter
IRT	Current Recording Transmitter
IT	Current transformer
JIT	Power Indicating Transmitter
JRT	Power Recording Transmitter
JSL	Power Switch Low (Power Failure Relay)
KI	Time Indicator (Clock)
KIQ	Total Runtime Meter
LDIT	Level Differential Indicating Transmitter
LE	Level Element
LI	Level Indicator or Gauge
LIC	Level Indicating Controller
LIT	Level Indicating Transmitter
LRT	Level Recording Transmitter
LSH	Level Switch High
LSHH	Level Switch High-High
LSL	Level Switch Low
LSLL	Level Switch Low-Low
LT	Level Transmitter
PDIT	Pressure Differential Indicating Transmitter
PDS	Pressure Differential Switch
PDSH	Pressure Differential Switch High
PE	Diaphragm or Annular Diaphragm
PG	Pressure Indicator or Gauge
PIC	Pressure Indicating Controller
PIT	Pressure Indicating Transmitter
PRT	Pressure Recording Transmitter
PSH	Pressure Switch High
PSHH	Pressure Switch High-High
PSL	Pressure Switch Low
PSLL	Pressure Switch Low-Low
SI	Speed Indicator or Gauge
SIT	Speed Indicating Transmitter
SRT	Speed Recording Transmitter
SSH	Speed Switch High
SSL	Speed Switch Low
TE	Temperature Element
TI	Temperature Indicator or Gauge
TIC	Temperature Indicating Controller, Thermostat
TIT	Temperature Indicating Transmitter
TRT	Temperature Recording Transmitter
TSH	Temperature Switch High
TSL	Temperature Switch Low
TT	Temperature Transmitter
VE	Vibration Element

Fragment 3	Instrument/Signal Description
VI	Vibration Indicator
VIT	Vibration Indicating Transmitter
VRT	Vibration Recording Transmitter
VSH	Vibration Switch High
VSL	Vibration Switch Low
WIT	Weight/Force/Torque Indicating Transmitter
WRT	Weight/Force/Torque Recording Transmitter
WSH	Weight/Force/Torque Switch High
WSL	Weight/Force/Torque Switch Low
XSF	Shear Pin
YAN	Alarm Horn
YL	Status Light
ZIC	Position Indicating Controller
ZIT	Position Indicating Transmitter
ZRT	Position Recording Transmitter
ZSH	Position Switch High (Open)
ZSL	Position Switch Low (Closed)
ZSM	Position Switches Intermediate

Assign instrument codes in the same manner as equipment codes.

2.2.4 Fragment 4 (Loop Number)

Generally, the Equipment/Loop number is a four digit number (0001 to 9999).

The numbering sequence for the loop number in fragment 4 of the tagnames is assigned within ranges associated with different process areas, and with numbers increasing sequentially according to flow or process direction. Major devices will be given round numbers, e.g. ending with “0”, and devices associated with those major ones will have a loop number in the same series, starting with NNN1.

Where equipment is not associated with a major unit, assign numbers starting with NNN1.

Table 9 and Table 10 provide the guideline for loop numbering ranges in relation to typical process areas at the water treatment plants, and remote facilities respectively. For loop numbering associated with any other process area code used based on the Table 4, consult the City of Greater Sudbury.

Table 9: Equipment Loop Number Assignment per Plant Process Areas

Process Area (Fragment 2)	Process Area Loop Range (for Fragment 4 Assignment)
RW/IPS	0100-0999
SED	1000-1099
DIS	1100-1199
LIM	1200-1299
ALM	1300-1399
POL	1400-1499
FL	1500-1599
PPH	1600-1699

Process Area (Fragment 2)	Process Area Loop Range (for Fragment 4 Assignment)
FLT	1700-1799
TRW	1800-1899
EN	2000-2099
DST	2100-2199
AUX	2200-2399

Table 10: Equipment Loop Number Assignment for Remote Sites (per Site Type)

Process Area (Fragment 2)	Process Area Loop Range (for Fragment 4 assignment)
WPS	0100-0199
RES	0200-0299
BPS	0300-0399
LS	0400-0499
OCF	0500-0599
XXX	0600-0699

The numbering sequence will follow and be synchronized with existing compliant tags within facilities.

2.2.5 Fragment 5 (Signal/Data Code)

Signal/Data code usage covers physical signals related to both real I/O in the SCIS design, as well as virtual points, e.g. those derived from a single analog signal such as average, minimum, maximum, total flow, or those communicated between the PAC and the HMI, or internal variables created in PAC programming.

As a minimum, signal and data points are to be assigned point tags for all data transferred between programmable devices and all points in the HMI and the historical databases.

Most of the commonly used signal/data codes are included in Table 11 below.

Where used in Table 11, “x” represents the physical quantity, such as flow, level, pressure, analytical measurement, temperature, etc. Substitute "x" in the first column of the following table with an ISA "FIRST LETTER" such as “A” (for analysis), “P” (for pressure), "F" (for flow), "L" (for level), "T" (for temperature), "W" (for weight), etc., as applicable, and substitute “x” in the description column with the name of the corresponding physical quantity. “x” in “xD” for identification of differential quantities is to be substituted with “PD” for differential pressure, with “LD” for differential level, with “SD” for differential speed, etc.

Table 11: Signal/Data Code

Fragment 5	Signal Description
xAH	"x" Hi Alarm
xAHH	"x" HiHi Alarm
xAHL	"x" High/Low Alarm
xAL	"x" Lo Alarm
xALL	"x" LoLo Alarm
xAOH	Out of Range High

Fragment 5	Signal Description
xAOL	Out of Range Low
xASG	Signal Error
xASI	Deviation Alarm "x"
xAW	"x" Alarm Warning
xC	"x" Control/Set-point
xI	"x" Indication
ACPF	AC Power Failure
CNT	Number of Starts/Cycle Count
CNTHI	High Number Of Starts
COMF	Communication Alarm
CS	Control Status
DBH	Hi Deadband
DBHH	HiHi Deadband
DBL	Lo Deadband
DBLL	LoLo Deadband
DCPF	DC Power Failure
EA	Voltage phases A-B
EAL	Loss of Power Alarm
EB	Voltage - Phase B-C
EC	Voltage - Phase C-A
EL	Voltage Low (Low Battery)
ENH	Hi Enable
ENHH	HiHi Enable
ENL	Lo Enable
ENLL	LoLo Enable
ES	Emergency Power (Gen/ATS)
EUMN	Engineering Unit Minimum
EUMNS	Speed Engineering Unit Minimum
EUMNZ	Stroke Engineering Unit Minimum
EUMX	Engineering Unit Maximum
EUMXS	Speed Engineering Unit Maximum
EUMXZ	Stroke Engineering Unit Maximum
H	Hi Limit
HAS	Emergency Stop
HBR1	Remote IO Rack 1 Heartbeat Alarm
HBR2	Remote IO Rack 2 Heartbeat Alarm
HBR3	Remote IO Rack 3 Heartbeat Alarm
HBR4	Remote IO Rack 4 Heartbeat Alarm
HBR5	Remote IO Rack 5 Heartbeat Alarm
HBR6	Remote IO Rack 6 Heartbeat Alarm
HH	HiHi Alarm Limit
HHT	HiHi Limit Temporary
HISI	Speed Automatic Set-point
HIYU	Computer Auto Mode Request
HSMH	Manual Start Request
HSMHH	Manual Start Request High Speed

Fragment 5	Signal Description
HSMHL	Manual Start Request Low Speed
HSML	Manual Stop Request, Drive or Valve
HSSC	Speed Manual Set-point
HSVH	Manual Open Request
HSVL	Manual Close Request
HSYU	Computer Manual Mode Request
HSYUS	Speed Computer Manual Mode Request
HSYUZ	Stroke Computer Manual Mode Request
HSZC	Manual Mode Position Set-point
HSZISC	Stroke Manual Set-point
HT	Hi Limit Temporary
II	Current Draw Indication
IIA	Current - Phase A
IIB	Current - Phase B
IIC	Current - Phase C
JQ	Energy
KDH	Hi Time Delay
KDHH	HiHi Time Delay
KDL	Lo Time Delay
KDLL	LoLo Time Delay
KDY	Current Day (PAC)
KHR	Current Hour (PAC)
KMN	Current Minute (PAC)
KMT	Current Month (PAC)
KQ	Runtime (Hours)
KQC	Runtime - Current
KQD	Runtime – Daily
KQM	Runtime – Monthly
KQ_RST	Runtime - Stats. Reset
KQS	Runtime - Total Starts
KQT	Runtime - Total
KQY	Runtime Yearly
KSC	Current Second (PAC)
KYR	Current Year (PAC)
L	Lo Limit
LK	Process Lockout
LK1	Process Lockout Alarm 1
LK2	Process Lockout Alarm 2
LK3	Process Lockout Alarm 3
LK4	Process Lockout Alarm 4
LK5	Process Lockout Alarm 5
LL	LoLo Limit
LLT	LoLo Limit Temporary
LOE	Loss of Echo
LT	Lo Limit Temporary
MN	Running Status

Fragment 5	Signal Description
MN_E	Emergency Run Status
MNH	Running High Speed
MNL	Running Low Speed
MN_M	Maintenance Run Status
MN_S	SCADA Run Status
MF	Motor Failed
MH	Start / Run Command
MHF	Start Command Forward
MHH	Start Command High Speed
MHL	Start Command Low Speed
MHR	Start Command Reverse
MHS	Start Set-point
MHY	Restart Inhibitor
MHYH	Restart Inhibitor High Speed
MHYHR	Restart Inhibitor Time Remaining High Speed
MHYL	Restart Inhibitor Low Speed
MHYLR	Restart Inhibitor Time Remaining Low Speed
MHYR	Restart Inhibitor Time Remaining
ML	Stop Command
MLS	Stop Set-point
NP	Normal Power (Gen / ATS)
OL	Overload
OS	In Service/ Out Of Service
OVSW	Long Scan Time
RF	Refresh Alarm Limits
RFQXA	Sequence Error
RFS	Set-point Update
RFSQ	Sequence Update
RFSXA	Set-point Error
RFXA	Alarm Limit Check Fail
ROC	Rate Of Change Alarm
RWIN	Raw Analog Input Value
RWSI	Raw Speed Input Value
RWZI	Raw Stroke Input Value
RWZIS	Raw Stroke Input
SAOH	Speed Out of Range High Alarm
SAOL	Speed Out of Range Low Alarm
SASG	Speed Signal Error
SASI	Speed Deviation Alarm
SC	Speed Output
SI	Speed Feedback
SQ	Sequence Number
SQA	Sequence Aborted Alarm
SQH	Sequence Holding/Waiting
SQI	Sequence Inhibited/No Permissive
SQT	Sequence Temporary

Fragment 5	Signal Description
STS	PAC Status
TMHS	Start Set-point Temporary
TMLS	Stop Set-point Temporary
TXF	Transmitter Failure (4-20 mA)
UN	Unavailable
VH	Open Command
VL	Close Command
XA	General Alarm
XAAP	Application Fault
XABAT	Battery Failure
XAC	Critical Alarm
XACPU	CPU Hardware Problem
XACR	Controller Fault
XACRF	Controller Fault Table Full
XAHD	Hardware Fault
XAI	Analyzer/Transmitter Fault
XAIO	IO Fault
XAIOC	IO Module Communication Error
XAIOF	IO Fault Table Full
XAIOP	IO Fault Present
XAJ	Major Alarm
XAM	Minor Alarm
XAMH	Fail to Start Alarm
XAMHF	Fail To Start Forward Alarm
XAMHL	Fail to Start/Stop Alarm
XAMHR	Fail To Start Reverse Alarm
XAMHU	Uncommanded Start Alarm
XAML	Fail to Stop Alarm
XAMLU	Uncommanded Stop Alarm
XARAM	Corrupted RAM
XASW	Software Fault
XAW	Warning
XAZ	Unknown Position Alarm
XAZH	Fail To Open
XAZHL	Fail to Open/Close Alarm
XAZHU	Uncommanded Open
XAZL	Fail to Close
XAZLU	Uncommanded Close
YA	Device Main/Control Power or Starter Failure Alarm
YI	Permissive
YN	Computer (Remote) Mode
YNDC	SCADA – Duty Change Request
YNHS	SCADA - Control Mode
YNHSS	Speed Computer Manual Mode
YNHSZ	Stroke Computer Manual Mode
YNLO	SCADA - Lockout

Fragment 5	Signal Description
YNMH	SCADA - Start Request
YNMHH	Automatic Start Request High Speed
YNMHL	Automatic Start Request Low Speed
YNML	SCADA - Stop Request
YNS	Speed Computer Mode
YNSP	SCADA - Speed / Position / Level Set-point
YNVH	SCADA - Open Request
YNVL	SCADA - Close Request
YNYN	Computer (Remote) Auto Mode
YNYNS	Speed Computer Auto Mode
YNYNZ	Stroke Computer Auto Mode
YNYU	SCADA - Alarm Reset
YNZ	Stroke Computer Mode
YNZIC	Automatic Mode Position Set-point
YUA	Acknowledge
YUF	PAC Fault Table Reset
YUIF	PAC IO Fault Table Reset
YURF	Refresh Reset
YURFQ	Sequence Error Acknowledge
YURFS	Set-point Error Acknowledge
YUS	Speed Computer Auto Mode Request
YUST	Start Count Reset
YUZ	Stroke Computer Auto Mode Request
ZAOH	Stroke Out of Range High Alarm
ZAOL	Stroke Out of Range Low Alarm
ZASG	Stroke Signal Error
ZASI	Stroke Deviation Alarm
ZH	Opened Position
ZI	Position Feedback
ZIS	Stroke Feedback
ZISC	Stroke Output Set-point
ZL	Closed Position
ZXA	Position Deviation Alarm

Codes for other signals and data not found in the list above can be generated using the following guidelines:

1. Use ISA coding methods and the above standard instrument letter identification tables.

2. Create as few special codes as practical.

3. Use abbreviations in a consistent manner. That is, use only one abbreviation for the same meaning.

4. Use the abbreviations in Table 12 and combinations of those abbreviations, as needed when creating new data codes for fragment 5:

Table 12: SCADA Signal Codes – Abbreviations

Abbreviation	Meaning
ACT	Actual
AVG	Average
BLK	Block
CLK	Clock
COND	Conditioned
CV	PID “CV” Control Variable
DB	Deadband
DT	Day of Week
DUPL	Duplicate
DV	Device
DY	Day
EN	Enable
FLT	Fault
HR	Hour
ID	Identity
JOG	Jog
L	Latched, usually as the last letter in a data code
MAX	Maximum
MED	Intermediate
MIN	Minimum / Minute
MTH	Month
ND	Needed, Required
NOR	Normal
OK	Okay, Successful
OV	Over
PID	Proportional Integral Derivative
PRE	Preset
PV	PID “PV” Process Feedback
READ	Read
REQ	Request
RF	Refresh
RS	Restart
SC	Scaled Value
SEC	Second
SEL	Select
SP	Set-point
T	Temporary, usually as the last letter in a data code
TM	Time / Timer
TMP	Temporary
TMR	Timer
TOT	Total
TRAN	Transition
UN	Under
VAL	Value
W	Word, followed by the number of the word

Abbreviation	Meaning
WRI	Write
YR	Year

2.3 Examples of Equipment and Loop Coding

The following are examples of equipment signal/data names. Note that fragments are separated by dashes, to offer clear indication of fragment ending. In addition, an underscore character "_" is used for clear indication of the start of the SCADA signal code (Fragment 5).

Underscores will be used instead of dashes in controller programming tagging.

Table 13: Equipment and Loop Coding Example 1

Facility Code	Process Area / Site Type Code	Device Code	Loop Number	I/O Data
1	**2**	**3**	**4**	**5**
WAN	**–TRW**	**–HLP**	**–1820**	
Wanapitei Water Treatment Plant	Treated Water – High Lifts	High Lift Pump	1820 defines high lift pump 2	Not applicable for device tag
WAN	**–TRW**	**–HLP**	**–1820**	**_YN**
				Remote Mode
WAN	**–TRW**	**–HLP**	**–1820**	**_XA**
				Common Fault
WAN	**–TRW**	**–HLP**	**–1820**	**_MN**
				Running Indication
WAN	**–TRW**	**–HLP**	**–1820**	**_MH**
				Start Command
WAN	**–TRW**	**–HLP**	**–1820**	**_ML**
				Stop Command

WAN-TRW-HLP-1820 for treated water High Lift Pump

Table 14: Equipment and Loop Coding Example 2

Facility Code	Process Area / Site Type Code	ISA Symbol	Loop Number	I/O Data
1	**2**	**3**	**4**	**5**
WAN	**–TRW**	**–LIT**	**–1801**	
Wanapitei Water Treatment Plant	Treated Water – High Lifts	Level Indicating Transmitter	No. 1	Not applicable for device tag
WAN	**–TRW**	**–LIT**	**–1801**	**_LI**
				Level Indication
WAN	**–TRW**	**–LIT**	**–1801**	**_LOE**
				Loss of Echo

WAN-TRW-LIT-1801 for Clearwell Level Indicating Transmitter

Table 15: Equipment and Loop Coding Example 3

Facility Code	Process Area / Site Type Code	ISA Symbol	Loop Number	I/O Data
1	**2**	**3**	**4**	**5**
WAN	**–IPS**	**–IP**	**–0100**	
Wanapitei Intake Pumping Station	Intake Pumping Station	Intake Pump	Pump 1	Not applicable for device tag
WAN	**–IPS**	**–V**	**–0101**	
Wanapitei Intake Pumping Station	Intake Pumping Station	Recirculation Valve	1st valve associated with the pump 1	Not applicable for device tag
WAN	**–IPS**	**–V**	**–0102**	
Wanapitei Intake Pumping Station	Intake Pumping Station	Check Valve	2nd valve associated with the pump 1	Not applicable for device tag

WAN-IPS-IP-0100, for Intake Pump No.1

WAN-IPS-V-0101, for Intake Pump No.1 Recirculation Valve

WAN-IPS-V-0102, for Intake Pump No.1 Check Valve

2.4 Flow Stream Identification

The flow streams for the process piping are identified per Table 16. These flow stream codes are to be used for identification of piping on P&ID's and other design drawings and documentation referencing process piping.

Table 16: Flow Stream Identification - Abbreviations

Code	Flow Steam Identification
AA	Atmospheric Air
AHP	Air, High Pressure Process
ALP	Air, Low Pressure Process
ALS	Alum Solution
ARCY	Anoxic Recycle
ARD	Acid Resistant Drain
ARV	Acid Resistant Vent
AS	Air Scour
ASL	Ash Slurry
ASPD	Acid Sump Pump Discharge
ASS	Ash Supernatant
AV	Acid Vent
AW	Acid Waste
BD	Biofilter Drain
BFE	Bio-Filter Effluent
BFI	Bio-Filter Influent
BFR	Bio-Filter Recycle
BFW	Boiler Feed Water
BN	Bioscrubber Nutrient

Code	Flow Steam Identification
BP	Backpulse Solution
BR	Brine Solution
BRI	Biological Reactor Influent
BS	Blended Sludge
BWD	Backwash Drain
BWR	Backwash Return
BWS	Backwash Supply
BWW	Backwash Waste
BYP	Bypass
CA	Compressed Air
CBG	Combustible Gas
CCB	Carbon Contactor Backwash Water
CCE	Carbon Contactor Effluent
CCI	Carbon Contactor Influent
CDG	Carbon Dioxide Gas
CE	Chlorinated Effluent
CGS	Cooling Glycol Supply
CGR	Cooling Glycol Return
CHWR	Chilled Water Return
CHWS	Chilled Water Supply
CIP	Clean-in-place Solution
CLG	Chlorine Gas
CLO2	Chlorine Dioxide
CLS	Chlorine Solution
CO	Condensate Drain
COA	Contaminated Air
CSD	Chemical Sump Discharge
CSF	Carbon Slurry Flush
CSM	Concentrated Scum
CTW	Contactor to Waste
CW	Condenser Water
CWR	Cooling Water Return
CWS	Cooling Water Supply
D	Drain (Sanitary)
DC	Dewatering Centrate Recycle
DCW	Decant Water
DEX	Dryer Exhaust
DG	Digester Gas
DI	Distilled Water
DIW	Deionized Water
DR	Drain
DS	Digested Sludge
DSC	Dewatered Sludge Cake
DSN	Digester Supernatant
DUS	Dust
DW	Distilled Water

Code	Flow Steam Identification
DWC	Dewatering Centrate
EFF	Effluent
EOF	Emergency Overflow
EQE	Equalization Effluent
EQI	Equalization Influent
EWW	Eyewash Water
EX	Exhaust Air
F	Filtrate
FCS	Fresh Carbon Slurry
FD	Fire Protection Dry Standpipe
FE	Filter Effluent
FEX	Furnace Exhaust
FF	Fire Suppression Foam
FI	Filter Influent
FO	Fuel Oil
FOR	Fuel Oil Return
FOS	Fuel Oil Supply
FS	Fire Protection Water Supply - Wet
FTW	Filter to Waste
FW	Finished Water
GAS	Gasoline
GR	Grit Slurry
GW	Ground Water
H	Hydrogen Gas
H2S	Hydrogen Sulfide
HFR	Hydraulic Fluid Return
HFS	Fluoride (Hydrofluosilicic Acid)
HGR	Heating Glycol Return
HGS	Heating Glycol Supply
HL	High Lift
HPHW	High Pressure Hot Water
HS	High Service
HW	Hot Water (Domestic)
HW2	Hot Service Water
HWR	Heating Water Return
HWS	Heating Water Supply
IA	Instrument Air
IS	Imported Sludge
LA	Laboratory Air
LC	Leachate
LCW	Laboratory Cold Water
LG	Lubrication Grease
LHW	Laboratory Hot Water
LIS	Lime Solution
LL	Low Lift
LO	Lube Oil

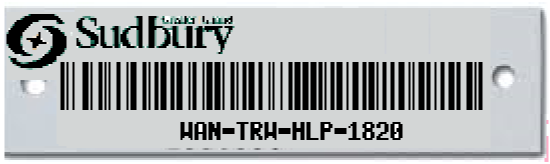
Code	Flow Steam Identification
LOX	Liquid Oxygen
LPG	Liquefied Petroleum Gas
LPO	Liquid Polymer
LPR	Low Pressure Return (Condensate)
LPS	Low Pressure Steam
LRHW	Laboratory Recirculating Hot Water
LV	Laboratory Vacuum
MD	Membrane Drain
MEG	Methane Gas
MF	Membrane Feed
MG	Natural Gas (Medium Pressure)
ML	Mixed Liquor
MOL	Methanol
MP	Membrane Permeate
MPR	Medium Pressure Return (Condensate)
MPS	Medium Pressure Steam
MS	Methanol Solution
NG	Natural Gas
NRCY	Nitrate Rich Recycle
OA	Odorous Air
OD	Overflow Drain
OF	Overflow
OG	Oxygen Gas
ORD	Overflow Roof Drain
OZ	Ozone
OZW	Ozonated Water
P	Propane Gas
PAE	Post Aeration Effluent
PD	Plant Drain
PDD	Plant Drain Discharge
PE	Primary Effluent
PI	Primary Influent
PLE	Plant Effluent
PS	Pressure Sewer
PSD	Primary Sludge
PSM	Primary Scum
PWE	Plant Waste Effluent
RAS	Return Activated Sludge
RCW	Recirculating Cooling Water
RD	Roof Drain
RDS	Recirculated Digested Sludge
REC	Recirculation
RHW	Recirculated Hot Water
RO	Reverse Osmosis
RPS	Return Primary Sludge
RS	Raw Sewage

Code	Flow Steam Identification
RVE	Reactivator Effluent
RVI	Reactivator Influent
RW	Raw Water
S	Sanitary Sewer (Gravity)
SA	Sample
SAB	Scrubber Acid Blowdown
SAC	Spent Activated Carbon
SBC	Caustic Scrubber Blowdown
SC	Scum Concentrate
SCL	Sodium Chlorite
SCR	Screenings
SCS	Spent Carbon Slurry
SD	Storm Drain
SDW	Scrubber Drain Water
SE	Secondary Effluent
SEP	Septage
SI	Secondary Influent
SL	Salt
SLG	Sludge
SPD	Sump Pump Drain
SPEO	Screened Primary Effluent Overflow
SR	Scrubber Recycle
SS	Sanitary Sewer
SSM	Secondary Scum
STG	Stack Gas
TASL	Thickened Ash Slurry
TC	Thickening Concentrate
TS	Thickened Sludge
TWAS	Thickened Waste Activated Sludge
TWS	Tempered Water Supply
UD	Under Drain
UVE	UV Effluent
V	Vent
VAC	Vacuum
VR	Vapour Recovery
VTR	Vent Through Roof
W1	No.1 (Potable) Water
W2	No.2 (Non-potable) Water
W3	No. 3 Water
W4	No. 4 Water
WAS	Waste Activated Sludge
WSP	Wet Standpipe
WWD	Washwater Drain
WWR	Washwater Return
WWS	Washwater Supply
WWW	Washwater Waste

3 Physical Tagging

All field equipment, instrumentation and panels require physical tagging. Physical tags are to identify the equipment tag name that is assigned to the equipment and is used in equipment documentation, drawings and, where applicable, in programming.

All field devices intended to be included in asset and CMMS data base require asset tag nameplates, which are based on .008” matte anodized aluminum as standard material, and consist of the City of Greater Sudbury logo, device tag name and the corresponding alpha-numeric bar code. Due to the contrast needed for bar code scanner, all engraving is to be black. Standard dimension of asset tags is 3” x 1 “. The figure below shows a sample asset tag nameplate.



A single device may require multiple physical nameplates, such as the main device identification tag, and additional tags identifying components that are part of the device. For example, a level sensor installed remotely from the corresponding transmitter will be tagged in the field with the nameplate that reads the same tag name as the transmitter’s nameplate, that being the tag name by which the instrument as a whole is identified. Or, a local control station dedicated to a single piece of physical equipment, for example a pump, will be tagged with the nameplate indicating the pump tag name. However, there will be only one asset tag with barcode, located at the main device, while all additional tag nameplates are to be provided based on the following standard requirements:

- Lamacoid, white with black lettering.
- Size to suit the equipment size (e.g. bigger tag nameplates on larger equipment, such as tanks), however chosen among standard sizes shown in Table 17.
- Two lines of text, first line showing the tag name, second line showing description.
- Text characteristics: Uppercase lettering, Times New Roman, Centered.

Table 17: Standard Name Plate Sizes

Tag Size (mm)	Lines of Text	Font Height
75 x 31 (3” x 1 ¼”)	2	line 1 = 6.5mm, line 2 = 5mm
150 x 38 (6” x 1 ½”)	2	line 1 = 12.5mm, line 2 = 9mm
250 x 50 (10” x 2”)	2	line 1 = 15mm, line 2 = 12.5mm

4 Submittals

Submittals related to the scope of this section of SCADA, Controls and Instrumentation Systems Design Standards will be provided in different phases of the project, as part of, and in accordance with overall course of project deliverables, as discussed in Section B – Automation System Project Delivery, and as summarized in Appendix B-1.

C-1 - Sample Add-Equipment and Maintenance Requirements Sheets

Section D

Instrumentation and Control Systems Design

1 Introduction

The overall intent and purpose of this section of the City of Greater Sudbury's SCADA, Controls and Instrumentation Systems Design Standards is to ensure that the Instrumentation and Control (I&C) design for the City's water and wastewater projects provides standardization of I&C products and consistency in design, in order to minimize the cost and scope of ongoing operations and maintenance. This Section will be followed in conjunction with all other sections of the City of Greater Sudbury's SCIS Design Standards.

This document and its Appendices are intended to provide standard guidelines and templates applicable to I&C design, but are not intended to provide completed designs. The Consultant will be responsible for properly following these guidelines when developing the design deliverables, as applicable to specific elements of the design and the specific project's scope. The Consultant will also be responsible for ensuring that the design is fully compliant with all applicable regulatory and industry standards.

If a deviation from any aspect of these SCIS Design Standards is proposed by the Consultant, it will be processed for the City of Greater Sudbury's approval through the standard deviation request, in accordance with Section A - General Requirements of the SCADA, Controls and Instrumentation Systems Design Standards.

2 Process & Instrumentation Diagrams Symbols and Practices

This section details the City of Greater Sudbury's requirements for creating and modifying Process and Instrumentation Diagrams (P&ID's) and is applicable to the design of new facilities, as well as to the design of upgrades and expansions of the existing facilities within the City's water and wastewater infrastructure.

This section is meant to establish a consistent way of showing information in the form of the P&ID, in order to define the standards that will be followed in each design project and design or construction contract that involves preparing or modifying P&ID's for the City of Greater Sudbury.

2.1 Purpose of P&ID's

P&ID's provide graphical representations of actual physical processes, showing the process, mechanical, and electrical equipment, and their interconnections, complete with controls and instrumentation information. P&ID's provide the main reference for matters related to instrumentation and the control system, as they summarize, in graphical form, the process functional relationships and monitoring and control strategies for specific field equipment.

In summary, P&ID's depict the following:

- Process equipment and process flow, including:
  - Piping arrangement,
  - Valves, pumps, mixers, blowers, centrifuges, and other process equipment,
  - Tanks and other process vessels,
  - Process related utilities' equipment (i.e. generators, ventilation fans, etc.).
- Primary elements, transducers, transmitters, analyzers, switches, panel face-mounted and internal-mounted instruments;
- Motor starters, actuators and other final control elements;
- Levels of control;
- Motor starter panels, control panels and panel interfaces;
- Hardwired signals, including process, HVAC, electrical, and miscellaneous mechanical equipment I/O and all hardwired interlocks;
- Identification of I/O type;
- Virtual points (where needed to clarify control logic);
- All hardwired totalizers and signal converters;
- Control signal interconnections.

P&ID's typically do not include equipment that is not directly associated with the operation of the process. For example, the P&ID set does not include such equipment as lights, power outlets and telephones.

The P&ID is the primary document which shows both process and control information. As such, it is a valuable tool during design, construction, and start-up.

P&ID's are used during SCADA, Controls and Instrumentation Systems design as a basis for development of:

- Field instrument schedule and specifications;
- I/O points list;
- PAC/SCADA control strategy design;
- PAC architecture and control panel design;
- Electrical interface definitions;
- Process, mechanical and electrical equipment tagging; and
- Overall design coordination.

During the construction and start-up phases of a project, P&ID's are used for:

- Shop drawing review of SCADA controls, control panel and loop wiring drawing submittals;
- Electrical interface coordination;
- Graphic display development/approval;
- Process control operational checkout;
- As-built drawings development;
- SCADA Manual development; and
- Training.

2.2 P&ID Development

The P&ID's are developed in stages in order to add information at the appropriate time, and they require the joint efforts of a Process Designer and a Controls Designer. P&ID's development stages are shown in the following table:

Table 18: P&ID Phases

Major Item	Preliminary Design	Detailed Design	Construction & As-Built
Piping, tanks, equipment and valves for main processes	Required	Required	Required
Ancillary piping and equipment	Not Required	Required	Required
Analyzers, sensors, transmitters, switches	Limited	Required	Required

Major Item	Preliminary Design	Detailed Design	Construction & As-Built
Starter type (e.g. soft starter, VFD), Actuator type (e.g. motorized, pneumatic)	Required	Required	Required
Details of starters and actuators (e.g. hardwired interlocks; air piping, pneumatic instrumentation)	Not Required or Limited	Required	Required
Panel - Face mounted instrumentation	Not required	Required	Required
Equipment and instrumentation I/O	Not Required or Limited	Required	Required

The draft P&ID development is to be done during the preliminary design phase. At the end of the preliminary design, the City of Greater Sudbury will review the P&ID's and, if satisfactory, the City will provide an approval to proceed with the detailed design phase.

During the detailed design phase, the P&ID's are further developed to implement feedback and suggestions made after the preliminary phase of the design, and to incorporate additional information and details to the design based on the selected equipment and instrumentation.

As-built P&ID's are prepared by the Consultant by updating the original design drawings, based on construction mark-ups provided by the Contractor. The As-built P&ID's are submitted to the City of Greater Sudbury at the end of the project. At this point, the P&ID's include all of the equipment, instrumentation and controls within the P&ID scope as they were implemented into the system.

For any retrofit or expansion project, the Consultant will request from the City of Greater Sudbury's Project Manager the set of the existing as-built master P&ID's for the facility prior to starting the preliminary design. The Consultant will discuss with the City of Greater Sudbury the approach in developing of the P&ID's for the scope of the project, such that all changes to the existing systems (e.g. equipment removals or addition of new equipment) are clearly shown in the design documentation prepared for definition of the construction contractor's scope, and are recorded in the Master P&ID set. For example, a new equipment P&ID provided for the project will eventually be included in the City of Greater Sudbury's Master P&ID set, while for a modification to the equipment already shown on existing P&ID, the existing drawing will be used and modified as required to depict the changes under the upgrade project's scope.

2.3 P&ID Layout

This Section is intended to provide guidelines to the Consultant, to ensure that P&ID's are presented in a consistent fashion on all drawings generated for the City of Greater Sudbury. Sample P&ID drawings are provided in Appendix D-2 of this Section.

2.3.1 Drafting Standards`

P&ID's will be developed in AutoCAD. The version of AutoCAD to be used is to be confirmed with the City of Greater Sudbury at the start of the project. The Engineering Drafting Standards for all City of Greater Sudbury drawings are available at:

http://www.greatersudbury.ca/business/engineering-standards/drafting-procedures/

These standards are to be applied to the generation of P&ID's in terms of drawing setup, use of drafting layers, line types, texts, drawing numbering, etc.

2.3.2 P&ID Orientation and Layout

For P&ID's, the rule for each drawing is to provide left to right orientation, following the process flow. A layered approach from bottom to top of the drawing sheet is to be used to distinguish the process flow diagram and various levels of control.

The bottom section of the drawing is used for representation of process equipment, and piping and instrumentation. Field instrument balloons are to be shown above or next to the field devices.

The next section of the drawing (above the field devices) is to be used for depiction of local controls, such as field control stations and local control panels, motor controls centres, local motor starter panels (e.g. field VFD control panels), and area control panels (e.g. Vendor package control panels). The information in this section of the P&ID will be coordinated between SCADA, Controls and Instrumentation designer and Electrical designer for consistency with control schematic drawings.

PAC/SCADA input/output symbols and tags are to be shown at the top section of the drawing. In this section of the P&ID, the PAC(s) tag number(s) are to be identified for cross reference with the I/O list, as well as a note indicating where OIT is included in the PAC panel.

The designer will also include notes on the P&ID to reference electrical control schematic drawings and equipment location drawings for control cabling and wiring requirements.

2.3.3 Instrument and Equipment Tagging

Instrument and equipment tagging is outlined in Section C - Equipment and Data Tagging of these SCADA, Controls and Instrumentation Systems Design Standards. Use of tag names and tagging abbreviations on the P&ID's, in conjunction with standard P&ID symbols is summarized in the P&ID legend sheets included in Appendix D-1, and demonstrated in the sample P&ID's in Appendix D-2.

2.3.4 Use of Typical Representation

Use of typical details can provide the simplification of complex P&ID's and can be used to rationalize otherwise repetitive information. Generally, typical details are used when the equipment, instruments and/or controls are of similar functionality within the process. For example, if valves 1 through 3 perform the same function for pumps 1 through 3 respectively, and have the same process control capability, then the monitoring and control signals for valve 1 may be drawn and shown on the P&ID in detail, while being noted as typical for the other two valves with similar process function and same control capability. For the monitoring and control signals for valves 2 and 3 in this example, a simple reference to typical representation showed for valve 1 can be made, with clear indication of any specific detail applicable, such as device and signal tagging.

In using typical controls, however, clarity must not be compromised. Therefore, as a primary approach generally, and especially if there is any potential for ambiguity, the Consultant will not typify even if additional drawings would be required to show the required details.

When using typical drawings for controls, the following rules and guidelines apply:

- Show all signals to and from the equipment for one typical piece of equipment, instrument or control.

- Show the equipment and loop numbers, and panel designations for all devices represented by the typical box.

In Appendix D-2, sample P&ID drawings provided illustrate the standard requirements in use for typical controls.

2.4 P&ID Standards and Symbols

The ISA standards and symbols for P&ID's are widely accepted and recognized throughout industry. The City of Greater Sudbury standards, and symbols and abbreviations for P&ID's, as presented on P&ID legend sheets are included in Appendix D-1, and are based on ISA Standards. These P&ID legend sheets will be included by Consultants in each instrumentation and control (I&C) drawing set developed for the City of Greater Sudbury.

Symbols and nomenclature not defined within the standards are not to be used without prior written consent by the City of Greater Sudbury Water and Wastewater Services SCADA Group SCIS Design Leader through the Standards revision request process, as per requirements and guidelines provided in Section A - General Requirements of these SCADA, Controls and Instrumentation System Design Standards.

The following general standard requirements apply to P&ID's. Some examples of application of these standards are illustrated in the sample drawings included in Appendix D-2.

- Symbols for the same piece of equipment, instrument or I/O point are not to be shown on more than one drawing.
- Balloons for field instruments and equipment are to be placed above or next to the device.
- All process hardwired interlocks are to be shown.
- For control panels, face mounted instruments are shown having a single, solid line across the instrument balloon.
- For motor starter panels and MCC's, face mounted instruments are shown having a double solid line across the instrument balloon.
- Package system panels are to be shown on process and sub-process P&ID's as boxes with face of panel mounted instruments and external I/O connections only. Interconnections, interlocks, interior signal function balloons, or signal function codes within the box that are internal to the package system are not to be shown.
- Signals which are to be terminated within a field/local control panel are to be shown by running the signal line up to the panel border. If the signal does not require termination in the panel, e.g. it is to be wired directly from the field instrument to the PAC panel, the signal is to be run straight through the control panel section of the P&ID's, around the control panels as required. A break symbol can be used where drafting a continuous signal line is not practical; matching ends of a broken line are to be clearly noted, as per the approach indicated in standard legends drawings.
- Close to each piece of process equipment, the equipment tag number is to be shown. For PAC/SCADA signals, a descriptive text is to be shown on top of the corresponding I/O point on the P&ID, along with the I/O point tag name.

2.5 Device Standard Signal Guidelines

For all devices, as applicable, the following monitoring and control signals are required to be shown on the P&ID.

As an example, for a pump, provide the following:

- Run status

- Local lockouts and hardwired interlock/fault signals
- Local/remote selector switch status
- Start/stop commands
- Status of Emergency stop pushbutton
- VFD speed set point, and speed indication (for variable speed pumps)

Examples of typical equipment I/O signals for different types of equipment are contained in Appendix D-10.

3 Process Control Narratives

3.1 General

This section is intended to provide guidance for the development of the Process Control Narrative (PCN), and is applicable to the design of the new facilities, as well as to upgrades and expansions of existing water and wastewater infrastructure.

Typically, the PCN is to be provided as part of the Consultant's design documents issued for construction contract tender, as a document that describes the detailed programming requirements for the scope of work of the System Integrator. Even in cases where the PAC/SCADA system programming for a project is not part of the Construction contractor's (i.e. System Integrator's) scope, it is recommended to include the PCN in the design documents issued for tender. The PCN must be submitted to the City of Greater Sudbury for review at specific project milestones, and approved prior to the commencement of software programming. The City of Greater Sudbury will be provided the opportunity to review the control strategies prior to the software being developed regardless of whether they are developed internally by the City or externally by a third party. Also, where programming is not part of the Contractor's scope, the Consultant is responsible for specifying all coordination requirements and Contractor's support required for software commissioning.

The Process Control Narrative forms an integral part of SCIS documentation and is a written description of key control system elements and how a control system will operate. It focuses on control philosophies, details of the manual and automatic modes of process control, including all software control functions, software interlocks, hardwired interlocks, alarms, set points, and historical data collection and trending requirements.

3.2 Process Control Narrative Preparation and Document Management

Process Control Narrative development is started by the Consultant during the preliminary design phase. The PCN's are expanded with more detail as part of the Consultant's detailed design.

The PCN should be completed by the time the detailed design phase has been completed, with submissions for the City of Greater Sudbury's Project Team review occurring at all major project's milestones (as identified in Section B of the SCADA, Controls and Instrumentation Systems Design Standards).

As required, the PCN is to be further updated, and associated revisions issued accordingly, during project implementation (i.e. construction, software testing and commissioning). The construction/implementation stage revisions of the PCN are to be provided by the System Integrator. The electronic version of the PCN will be provided to the System Integrator for all required updates.

At different stages of the project, the process control narrative is used for the following purposes:

- Preliminary Design Version - Used to develop the process concept and to document process objectives, and subsequently, equipment and operational requirements. During this stage, the document is typically developed by the Consultant's Process Designer and referred to as a Process Narrative. The pre-design process narrative will list, in generic terms, the equipment to be controlled and the proposed methods to be used.

- Detailed Design Version - Used to define the process control requirements including all instrumentation, tagging, hardwired and software interlocks, process control and alarm set points, data collection, trending and alarming associated with the process. At this stage, the Consultant's Instrumentation and Control Designer is involved in development of the PCN. All available modes of control are defined with descriptions on how different control modes and functions within them are achieved. The detailed design PCN provides a guideline to the System Integrator in developing the controls software.

- Operation Manual - Final version of the Process Control Narrative (PCN) will capture all changes that were completed during the construction and commissioning of the facility or process area. The System Integrator is responsible for maintaining the PCN up to date during construction and software development stage, and for providing the as-built version of the PCN. This document is to be developed in digital format using MS-Word. In particular, the 'track changes' feature will be used, such that any changes made to the document can be easily observed and reviewed by the Consultant and the City of Greater Sudbury prior to acceptance. The as-built PCN is to be inserted into the Operation Manual to provide documentation for the City of Greater Sudbury's record, and for use by operations and SCADA teams assigned to the facility.

Process Control Narratives will be written in accordance with all relevant City of Greater Sudbury SCIS Design Standards, i.e. control philosophy and hierarchy, required software development techniques, general requirements, etc., included in and/or referenced from the PCN will reflect the requirements of the Standards, while ensuring that the specific requirements of each process are defined.

The City of Greater Sudbury has a standard template for the development of the Process Control Narrative which is included in Appendix D-4. This template is to be used for the development of all PCN documents for the City on new, existing and upgrade projects.

Where there is an existing City of Greater Sudbury as-built PCN for a specific process or facility, the existing PCN will be used as a reference document and updated by the Consultant for the scope of upgrade works. When that is not feasible, a new PCN is to be developed following this standard. An electronic master file will be made available by the City of Greater Sudbury for use by the Consultant working on updating an existing Process Control Narrative. At the end of the project, the City of Greater Sudbury Master PCN for the facility will be updated for the as-built version. If the existing PCN is to be updated, however it has not been provided in the SCIS standard format, the Consultant will be responsible for proper formatting of all of the existing sections affected by the scope of work of their upgrade project and any new sections.

Where a new PCN has been developed, its as-built version will become the City of Greater Sudbury's Master PCN for the corresponding process/facility.

4 Approved Manufacturers and Suppliers

Appendix D-5 contains a table which provides a list of approved manufacturers for instruments and control panels and equipment for use with City of Greater Sudbury wastewater or water projects. Designers are to adhere to the approved manufacturer's list. Any suggested deviation from these tables will require City of Greater Sudbury's approval through the standard deviation request process.

Also, when preparing tender documents, the Consultant will verify the manufacturers cited in the approved list are still available. If a manufacturer is no longer available, the Consultant will make a recommendation to the City of Greater Sudbury for a suitable replacement, and for consequent revision of the Standards.

If a Contractor proposes the use of a product other than one from the approved list specified by the Consultant, and the proposal is accepted by the City of Greater Sudbury and Consultant, should any redesign be required, it is to be completed by the Contractor at no additional cost to the Contract.

For the purposes of limiting support costs and maintenance costs, it is recommended to use one instrument manufacturer/distributor from the approved lists for as many products as practical.

5 Instrumentation

5.1 General

This section describes the City of Greater Sudbury standard requirements for Consultant's design of instrumentation for new water and wastewater facilities or upgrades and expansions of existing ones.

5.2 Instrumentation Design Documentation

5.2.1 Standard Instrument Specification

A standard Instrumentation General Specification document is provided as part of this Section of the City of Greater Sudbury SCIS Design Standards, in Appendix D-7.

The Consultant will use this specification when developing the instrumentation design on any specific project, and will complement it with relevant specific information which is to be shown on drawings, such as P&ID's, layout drawings showing instrument locations, and instrument data sheets and standard mounting details.

5.2.2 Standard Mounting Details

A typical set of standard mounting detail drawings are included in Appendix D-6. These may be used as the general basis for a design, however on a project by project basis, manufacturer's mounting details are to be followed.

In addition to the installation requirements included in the standard specification, the Consultant will specify any special requirements, as applicable to comply with the manufacturer's recommendations.

5.3 Instrumentation Design Guidelines

Consultant's design must clearly specify the process/service requirements, sensor and transmitter characteristics, performance and installation requirements, and physical construction and enclosure requirements for each instrument, to address the specific process applications and all environmental and classification aspects affecting instrumentation design. Instrumentation General Specification from Appendix D-7 of these SCADA, Controls and Instrumentation System Design Standards summarizes all standard general requirements applicable to instrumentation, to be followed by the Consultant's design and specified accordingly for the construction Contractor's scope of work on any specific project.

As well, the Consultant will develop specific instrument data sheets for all instrumentation in the scope of the project. Data sheets for new instruments will be prepared following ISA standard format. The data sheets will be completed by the Consultant during the detailed design for all items relevant for design specifications. Data sheets will be finalized by the Contractor during construction stage for specific product/part number and manufacturer information, as part of instrumentation shop drawing submittals, and will be updated as required for as-built and inclusion in Operation and Maintenance manuals.

In the Consultant's design specifications, a common specification data sheet can be prepared for each group of instruments of a same type (e.g. electromagnetic flow meter), along with Instrument List, in which the unique tags and specific data (e.g. process fluid, calibration range, line size) are identified.

A template for the standard Instrument List is included as part of Instrumentation General Specification in Appendix D-7.

The Consultant will specify all instrumentation to be new, and to be purchased via official Ontario distribution channels, where one exists, that are authorized to sell, service, and support the equipment and have the responsibility to warranty its performance.

The Consultant will specify spare parts required to commission instruments, and those that are to be stocked for prompt intervention on critical instrumentation which require repair in less than three days. Also to be specified are all general and specific expectations related to availability of distributor's supplies and services, such as

- On-site technical support to be available within XX hours.

6 Control Panels

6.1 General

Control Panels equipped with controllers (PACs) are referred to in these Standards as Instrument Control Panels (ICP's). Generally, ICP's will be supplied per process area. Multiple ICP's in one process area are acceptable where required.

This section describes the City of Greater Sudbury standard requirements for control panels for new water and wastewater facilities or upgrades and expansions of existing infrastructure.

This standard is to be followed by all Consultants. The design guidelines expressed in this document are to be understood and followed in conjunction with the details provided on standard panel design drawings in Appendix D-8, and standard panel specification in Appendix D-7.

The ICP design standards also apply to prepackaged Vendor PAC panels (i.e. ICP's packaged with process equipment such as compressors, waste gas burners, boilers, centrifuges, large blowers and chemical preparation systems), and the Consultant must ensure that the same standards are enforced in all affected specifications developed for Vendor supplied packages. For further guidelines related to development of specifications for Vendor package-supplied panels and associated components and programming, refer to Section B of these SCADA, Controls and Instrumentation Systems Design Standards and to associated Appendix B-3.

6.2 Instrument Control Panel Design Documentation

6.2.1 Panel Specifications

Prior to designing a new system, the Consultant must check if an existing PAC, compliant with the City of Greater Sudbury controller standards, is already in the process area. If a standard PAC exists, and there is available I/O hardware capacity and free memory in the processor, new instrumentation and controls will be tied into the existing PAC.

The Consultant will prepare a detailed specification for provision of new ICP(s), and/or upgrade of the existing ICP(s) under the project's scope. A standard panel specification will be used as a guideline and template, as provided in Appendix D-7. In addition, the Consultant will populate a schedule of ICP(s), identifying all specific individual panel requirements.

A template for the standard ICP schedule is included as part of Instrument Control Panels specification in Appendix D-7.

6.2.2 Standard Drawings

Standard control panel layout, and power distribution and I/O wiring drawings for typical panels are contained in Appendix D-8. The Consultant will refer to these drawings as part of this Section's requirements, and will utilize them, customized as required, in preparation of the drawings for any specific project.

For every project, the Consultant is responsible to prepare all required typical panel drawings, and PAC I/O lists including the following:

- Typical panel layout, external and internal, panel power distribution, and bill of material drawings for all different panel types provided under the scope.

- Typical I/O wiring drawings for each type of I/O cards, by choosing a sample I/O card of each type to show a complete, scope-specific, I/O loop wiring for that card.
- Detailed controller rack(s) layout with all required modules specified, and
- I/O list identifying the required I/O assigned to specific I/O points in PAC's hardware configuration.

The panel builder's scope under the construction contract, as specified by the Consultant, will include the requirement for detailed panel drawings based on the Consultant's typical drawings, and finalize them per as-built condition. Those drawings will include all specific information, such as panel dimensions, enclosure rating, specific layout and bill of material, and complete loop drawings for all I/O cards.

Refer to Appendix D-8 for an example set of typical panel drawings and detailed drawings of a sample ICP.

Field equipment with standardized I/O interfaces should be specified in the device specifications to allow standardized I/O blocks to be used in the PAC/SCADA programming. Examples of typical equipment I/O interfaces are contained in Appendix D-10.

6.3 Instrument Control Panels Design Guidelines

The following sections include general requirements related to instrument control panel design. While completing the design for any specific project, the Consultant will follow the guidelines from these sections in conjunction with the detailed requirements included in the ICP standard specification/template in Appendix D-7, and with the sample ICP drawings in Appendix D-8 and will customize any special requirements applicable to specific instances of ICP's which are to be provided for the project's scope.

6.3.1 Panel Enclosure Design

General requirements for control panels and enclosures in summary include:

- Specify the ICP's NEMA rating such that the enclosure is suitable for the application and the environment, and according to the area classification.
  - Panels are to be minimum NEMA 12 type, such as for installation in electrical/control rooms, and NEMA 4/4X for installation in process areas.
  - No panels are to be placed in Class 1/ Division 1 hazardous locations.
  - Outdoor panels and panels in chemical areas are to be stainless steel 316; indoor panels (process areas other than chemical rooms) are to be mild steel.
- Specify Instrument Control Panel enclosure finishing requirements depending on panel rating.
  - Stainless Steel: Not painted.
  - Steel Panels: Painted, interior and exterior.
- Specify control panel enclosure environmental requirements. The default indoor conditions are: temperature from 0ºC to 50ºC and humidity of 95% RH, non-condensing. The default outdoor condition temperature is from -40ºC to 50ºC. The Consultant must identify panel service conditions if different than defaults, and show them in the panel schedule.
- Outdoor panels will be specified to have double door enclosures with legs, mounted on a concrete pad; enclosures to be monitored for intrusion and hi/lo temp alarms (signals to be shown on P&ID and included in PAC I/O list).

- Specify all door mounted and internal panel mounted equipment and specify installation requirements to maintain the panel's NEMA rating.
- Specify all panels and cabinets with print pocket, and internal foldable laptop shelf.
- Specify panel and components identification and labeling requirements. Follow recommended practice for nameplates, labels and tags, as defined by ISA RP60.6-1984, Nameplates, Labels and Tags for Control Centers, and follow the requirements of Section C – Equipment and Data Tagging of these SCADA, Controls and Instrumentation Design Standards.

Minimum depth for an ICP enclosure will be 24 inch for free-standing enclosures, and 18 inch for wall-mounted enclosures. Design standard panels that are large enough to contain all required equipment, with minimum 25% additional space for expansion.

The final panel size depends upon:

- The internal panel components,
- The quantity of each type of I/O,
- Panel internal wiring and space for field wiring,
- The physical location of the panel.

Size panels to allow for:

- 25% spare I/O
- 25% spare terminal blocks
- 25% spare space.
- Single-rack PAC panels must allow space for a future rack, and spare space for terminals and wiring for the future rack is to be sized accordingly.

For all spare I/O points, the Consultant will design and specify that the panel is to be supplied with all terminal blocks and internal I/O wiring from the spare I/O to the terminal blocks, or to spare interposing relays. This ensures that when an expansion requiring these spare I/O occurs, the corresponding field wiring only has to be landed on the existing terminal blocks. It avoids field panel retrofits and on-site Panel FATs.

Consultants will avoid sizing panels with field terminal blocks mounted on the sidewalls. The panel will be sized large enough to mount all field terminal blocks on the main back plate.

6.3.2 Control Panel Power Distribution

Instrument Control Panel(s) voltage is 120VAC maximum. This includes ICP's provided as part of a Vendor equipment package. For Vendor Package panels, medium voltage starters must be separate from the ICP's housing the PACs.

The Consultant will confirm with the City of Greater Sudbury, and clearly show it on the panel power distribution drawings, the requirement for supply of utility power to the ICP from either a single or from two sources.

Each Instrument Control Panel must have one Transient Voltage Surge Suppressor (TVSS) installed before a power receptacle dedicated to power the UPS.

The instrument control panel must have a UPS, which is to be mounted on inside floor of ICP, and an external UPS maintenance bypass switch, configured such that it automatically switches to utility power on UPS fault.

The PAC chassis will be powered by UPS. The input and output cards will be powered by UPS. All field instruments and network equipment will be powered by UPS.

Protect each 120 VAC instrument power circuit with a panel mounted circuit breaker sized to suit.

For 120 VAC power distribution to any panel mounted equipment, circuit breakers will also be used.

Specify two (2) 120 VAC/24 VDC (5Amp Min.) redundant power supplies, complete with redundancy module, to be fed from UPS power distribution.

24 VDC I/O cards, 24VDC 4-wire instrumentation, panel light, OIT where applicable, will be powered from the panel DC power distribution. Individual circuits will be protected with fuses, sized according to the load requirements.

6.3.3 Control Panel Components and Construction

All equipment and assemblies of equipment are to be fabricated in a CSA approved shop.

The PAC hardware selections for ControlLogix and CompactLogix racks and modules are presented in Section E - Controller standards, and will be followed in the design of new and expansion PAC configurations. Also, when designing PAC hardware configuration, the Consultant will follow the standard chassis layout as per requirements of Section E.

All I/O for a process device are to be designed to be terminated in the same PAC panel controlling the device, even if another PAC panel is physically closer. Device I/O can be spread across multiple racks within the same PAC panel, but cannot be spread between two PAC panels even if one panel is a remote I/O panel for the other.

Spare slots will be designed for each type of I/O card. The Consultant must obtain approval from City when specifying less than the required number of spare slots if using existing PAC. Slot Fillers are to be specified for all spare slots.

For wiring from hazardous areas, intrinsically safe field panels are to be provided separate from the ICP. If, for any reason, a separate panel is not provided, intrinsically safe barriers will be specified for installation in the ICP for all I/O wired from the hazardous areas. The Consultant will discuss and confirm the approach with the City of Greater Sudbury during the detailed design stage.

All panel wiring is to be neatly dressed and run in plastic duct with AC and DC conductors in separate ducts.

Separate wire ducts are to be designed for field wiring and internal panel wiring. Allow for duct of sufficient width/depth to accommodate all incoming field wiring.

ICP will have two separate grounds, one for instrument grounding (i.e. 4-20 mA cable shields etc.) and one for control circuit grounding (i.e. case grounds, control circuits, etc.).

ICP will include an Ethernet RJ-45 to RJ-45 with 120VAC outlet to be mounted on the exterior of the front door of the panel (closest to the door hinged side), with a protected housing.

6.3.3.1 Terminal Blocks

Specify European style DIN rail mount terminal blocks. Only specify non-stackable terminal blocks.

“Knife-switch” field terminal blocks are to be specified on all analog 4-20 mA loops to permit easy electrical isolation of the loop and connection of an ammeter into loop.

Fused terminal blocks with neon “fuse blown” indicator on a knife switch are to be specified for all digital loops to electrically isolate the loop.

Specify 25% spare terminals evenly distributed across terminal strips for all terminal blocks.

Specify terminal installation, partitioning, and identification requirements, to provide required separation of power, control wiring, instrument wiring and ground points.

I/O Terminal Blocks will be assigned per I/O card, and grouped by I/O card type, and signal voltage level. Terminal block groups are to be labelled by rack and slot numbers, while spare I/O terminal blocks are to be marked spare.

6.3.4 General Installation Requirements

ICP’s will be installed in accordance with requirements of this standard, as per standard panel specification in Appendix D-7, and the standard panel drawings in Appendix D-8. The Consultant will specify further installation details as required to conform to the specific field conditions.

The Consultant will determine the locations of ICP’s and show them on the corresponding floor layout drawings. The locations will be chosen based on general area requirements, proximity to the equipment which is to be wired to the ICP, and such that, once installed, the panels are easily accessible for maintenance and readability of displays.

7 Field Signal Interface Standards

7.1 Field Instrument Signals

7.1.1 Analog Input Signals

Standard for PAC analog input signals for all City of Greater Sudbury applications is 4-20 mA, with HART capability.

All analog input loops will be 4-20 mA linear, isolated current loops for single signal instrument, capable of handling loads of up to 750 ohms. Analog loop loads are not to exceed the manufacturer's recommended limit.

Analog signal integrity must be ensured throughout the loop and at all times. The signal must provide a continuous measurement over an entire range (i.e. 0 to 100%) of a predefined full-scale value. The signal span will be linear over the 4-20 mA range.

As required, specify converters for any non-standard analog signals conversion to the 4-20 mA standard.

7.1.2 Analog Output Signals

The City of Greater Sudbury's standard for PAC analog output signals for all City of Greater Sudbury applications is 4-20 mA, with HART capability.

All analog output loops will be configured using 2 wire circuits. The PAC system must provide loop power and be the ground reference. Each individual analog output loop must be capable of being independently isolated.

7.1.3 Discrete Inputs

The City of Greater Sudbury's standard for PAC discrete inputs voltage is 24 VDC. Deviations from this signal standard require the City of Greater Sudbury SCADA Group approval.

All discrete inputs that are used to indicate alarm condition must be wired as "Fail-Safe". This means the discrete input is normally on or high and loss of the signal (i.e. low state) indicates the alarm condition.

7.1.3.1 ICP-Based Standard Discrete Inputs

The fuses feeding 24 VDC DI are to be fail-safe monitored through a common fault to PAC, wired to input 15 on each DI card.

Instrument Control Panel 120 VAC power supply circuit is to be monitored for loss of power before and after UPS, as well as UPS fault, and 24 VDC power supply fault (a common fault for the dual power supply configuration).

7.1.4 Discrete Outputs

The City of Greater Sudbury's standard for PAC discrete outputs is 120 VAC, isolated outputs. That is to be confirmed with the City at the beginning of design.

All discrete outputs will be wired to interposing relays inside the ICP.

7.1.4.1 ICP-Based Standard Discrete Outputs

As a standard approach, specify ICP panel indication lights for indication of PAC logic generated common alarm, and for indication of PAC communication failure respectively.

Assign two discrete outputs from the PAC to energize the respective pilot lights.

7.1.5 Communication Protocols

The City of Greater Sudbury standard for SCADA Architecture is based on Ethernet IP. Further details related to SCADA network requirements are covered in Section F - Networks and Communications.

In some cases, certain field devices which have Ethernet IP capability can be monitored through Ethernet communication. An example is PAC/SCADA monitoring of detailed VFD or power quality meter parameters through Ethernet. However, this may only be in addition to the standard I/O required for a device, as for all controls, and all essential monitoring, hardwired I/O signals will be designed and provided.

Specify all instruments to be Highway Addressable Remote Transducer (HART) communications protocol compatible.

HART provides access to all smart instrument parameters and diagnostics. Specify smart instrument calibration devices as required.

For all digital communication interfaces, wiring to be as per the approved manufacturer's standards.

Any other digital communication protocol must be approved prior to specification of any instrument.

7.1.6 Instrument Power Supply

All line voltage powered instruments are to be suitable for a 120 volt AC power supply. Provide a separate (independent) circuit, complete with adequately sized circuit breaker, to power each 4-wire instrument from the 120 VAC UPS power distribution in ICP. These circuit breakers will also be the main point of an instrument power disconnect, as required for maintenance.

24V DC instrument transmitters will be powered by fused DC power supply circuits located within the instrument control panel, from the ICP's 24 VDC power distribution.

8 Field Wiring and Conduits

8.1 Wire and Cable

All wiring and cabling will be specified to conform to the latest revision of the Canadian Electrical Code and to the Electrical Area Classification for Hazardous Locations where applicable. The Consultant is to ensure that the requirements of these standards are addressed in the field wiring specifications that may be part of Electrical division.

No control wire smaller than No. 14 gauge is to be used.

Shielded cables, as required, are to be specified as follows:

- Instrument single pair shielded cables with 600 volt insulation, No. 16 AWG twisted stranded copper, equal to Belden 1118A, and CSA approved.

- Multi-paired shielded cables individually shielded, complete with overall shield, No. 18 AWG, 600 volt insulation, equal to Belden 1051A, and CSA approved.

- RS 485 two pair low capacitance shielded cables with 300 volt insulation, No. 22 AWG twisted stranded copper conductors, equal to Belden 3107A, and CSA approved.

Specify concrete coring between floors as required. In existing facilities, floor X-ray inspections must be completed prior to any concrete coring to ensure there are no conduits or other infrastructure embedded in the floor.

Specify for provision of adequate slack on cable harnesses to permit easy removal of I/O and other printed circuit cards and/or modules and instruments during service or repair.

All feeders will be run in continuous lengths between power supply point and the load with no splices.

Provide adequate wiring of individual field device inputs to relays within the panel. Unless specifically required, wiring of devices (e.g. switches) in series to a common relay is not permitted.

As required, specify wiring as recommended by the system component manufacturers, such as wiring between sensors and transmitters or similar.

Specify conduit for all system wiring, except for power cords with integral plugs, and except where duct, tray or similar raceway are indicated in Electrical specifications.

Specify analog signal cabling including transducer cables and communication cables, to be installed in dedicated rigid conduits away from AC power and other EMF sources. Ultrasonic sensor cabling must be installed strictly in accordance with manufacturer’s instructions.

Specify lightning and surge protection for installation on all analog signal cabling entering or exiting buildings.

Specify signal isolators (24VDC externally powered if not loop-powered devices) as required on analog loops and communication wiring with cabling running outside buildings, and where recommended by equipment manufacturers on speed control signals into variable frequency drives and soft starters, and any situation where potential EMF could damage electronic equipment. The signal isolators will always be specified in applications for elevated tanks’ sites, where there is a potential of lightning strikes which could damage analog signal loops. Signal isolators are to be HART compatible.

Specify to seal all conduit terminations to prevent moisture penetration.

Communication and analog signal conductor shields must be isolated and taped back at the field end and terminated at a single ground point in the ICP.

8.2 Wiring Identification and Labelling

The City of Greater Sudbury has standardized on an approach related to wiring identification and labeling. The purpose of this standardization is to define general guidelines for signal and power wiring and cabling within the City of Greater Sudbury's SCADA, Control and Instrumentation systems.

Appendix D-9 defines the detailed requirements for specification of wiring tag names based on source and destination of wiring and cabling, and wiring and cabling types. The requirements of physical labels and their installation, and standard wiring color code are included in the control panel design specification in Appendix D-7. Consultant's design on any project will adhere to these requirements, and will be included in the design specifications accordingly.

9 Submittals

Refer to the submittals matrix in Appendix B-1.

D-1 - Standard P&ID Legend Drawings

D-1, C6642-1 Standard P&ID Legend Drawings (1).dwg

D-1, C6642-2 Standard P&ID Legend Drawings (2).dwg

D-1, C6642-3 Standard P&ID Legend Drawings (3).dwg

D-2 - Sample P&ID's with Example Use of Typical Controls

D-2, C6642-4 Sample P&IDs, 01-Typical Well.dwg

D-2, C6642-5 Sample P&IDs, 02-Typical Valve Chamber.dwg

D-2, C6642-6 Sample P&IDs, 03-Typical Meter Chamber.dwg

D-2, C6642-7 Sample P&IDs, 04-Typical Lift Station (2 pumps).dwg

D-2, C6642-8 Sample P&IDs, 05-Typical Water Tower.dwg

D-2, C6642-9 Sample P&IDs, 06-Typical Chemical Metering.dwg

D-2, C6642-10 Sample P&IDs, 07-Typical Chlorinators.dwg

D-2, C6642-11 Sample P&IDs, 08-Typical Hazardous Gas Monitoring.dwg

D-2, C6642-12 Sample P&IDs, 09-Typical Emergency Generator & Misc. Services.dwg

D-2, C6642-13 Sample P&IDs, 10-Typical Filter Backwash Station.dwg

D-2, C6642-14 Sample P&IDs, 11-Sample P&ID with Typical IO and Controls.dwg

D-3 - Drafting Standards
(Refer to the City of Greater Sudbury Vertical Works AutoCAD Drafting Standard, which forms part of this SCIS Design Standards Manual, however is saved and maintained as an independent document)

D-4 - Process Control Narrative Template

D-5 - Approved Manufacturer's, Water and Wastewater

D-6 - Standard Mounting Details

D-6, A2463-1 Standard Instr. Mounting Details - 01-Ultrasonic Level (Channel) .dwg

D-6, A2463-2 Standard Instr. Mounting Details - 02-Ultrasonic Level (Tank).dwg

D-6, A2463-3 Standard Instr. Mounting Details - 03-Depth & Level Probe.dwg

D-6, A2463-4 Standard Instr. Mounting Details - 04-Float Level Switch.dwg

D-6, A2463-5 Standard Instr. Mounting Details - 05-Magnetic Flow Meter_Sensor.dwg

D-6, A2463-6 Standard Instr. Mounting Details - 06-Magnetic Flow Meter.dwg

D-6, A2463-7 Standard Instr. Mounting Details - 07-Pressure Transmitter.dwg

D-6, A2463-8 Standard Instr. Mounting Details - 08-Temperature Thermowell.dwg

D-6, A2463-9 Standard Instr. Mounting Details - 09-Gas Sensor & Transmitter.dwg

D-6, A2463-10 Standard Instr. Mounting Details - 10-Gas Sample.dwg

D-6, A2463-11 Standard Instr. Mounting Details - 11-Free Chlorine Analyzer.dwg

D-7 - Standard Specifications

D-7 - Standard Specifications, Instrument Control Panels.docx

D-7 - Standard Specifications, Instrumentation and Controls General.docx

D-7 - Standard Specifications, Instrumentation Specification General.docx

D-8 - Control Panel Drawings, Typical

D-8, C6642-15 Control Panel Drawings, 01-Typical 2 Door Panel Layout.dwg

D-8, C6642-16 Control Panel Drawings, 02-Typical Bill of Materials.dwg

D-8, C6642-17 Control Panel Drawings, 03-Typical 120 VAC Control Wiring.dwg

D-8, C6642-18 Control Panel Drawings, 04-Typical 24 VDC Control Wiring.dwg

D-8, C6642-19 Control Panel Drawings, 05-Typical Digital Input Card & Ethernet Module.dwg

D-8, C6642-20 Control Panel Drawings, 06-Typical Digital Output Card.dwg

D-8, C6642-21 Control Panel Drawings, 07-Typical Analog Input Card.dwg

D-8, C6642-22 Control Panel Drawings, 08-Typical Analog Output Card.dwg

D-8, C6642-23 Control Panel Drawings, 01 Sample ICP Drawings Title Page.DWG

D-8, C6642-24 Control Panel Drawings, 02 Sample ICP Drawing Index.DWG

D-8, C6642-25 Control Panel Drawings, 03 Sample ICP External Panel Layout.DWG

D-8, C6642-26 Control Panel Drawings, 04 Sample ICP Internal Panel Layout and BOM.DWG

D-8, C6642-27 Control Panel Drawings, 05 Sample ICP PLC Module Layout.DWG

D-8, C6642-28 Control Panel Drawings, 06 Sample ICP Communication Diagram.dwg

D-8, C6642-29 Control Panel Drawings, 07 Sample ICP AC Power Distribution.dwg

D-8, C6642-30 Control Panel Drawings, 08 Sample ICP DC Power Distribution.DWG

D-8, C6642-31 Control Panel Drawings, 09 Sample ICP R0S03 Digital Inputs.DWG

D-8, C6642-32 Control Panel Drawings, 10 Sample ICP R0S04 Digital Inputs.DWG

D-8, C6642-33 Control Panel Drawings, 11 Sample ICP R0S05 Digital Inputs.DWG

D-8, C6642-34 Control Panel Drawings, 12 Sample ICP R0S06 Digital Inputs.DWG

D-8, C6642-35 Control Panel Drawings, 13 Sample ICP R0S07 Digital Inputs.DWG

D-8, C6642-36 Control Panel Drawings, 14 Sample ICP R0S08 Digital Outputs.DWG

D-8, C6642-37 Control Panel Drawings, 15 Sample ICP R0S09 Digital Outputs.DWG

D-8, C6642-38 Control Panel Drawings, 16 Sample ICP R0S12 Analog Inputs.DWG

D-8, C6642-39 Control Panel Drawings, 17 Sample ICP R0S13 Analog Inputs.DWG

D-8, C6642-40 Control Panel Drawings, 18 Sample ICP R0S14 Analog Outputs.DWG

D-8, C6642-41 Control Panel Drawings, 19 Sample ICP R0S15 Analog Outputs.DWG

D-8, C6642-42 Control Panel Drawings, 20 Sample ICP R1S01 Digital Inputs.DWG

D-8, C6642-43 Control Panel Drawings, 21 Sample ICP R1S02 Digital Inputs.DWG

D-8, C6642-44 Control Panel Drawings, 22 Sample ICP R1S03 Digital Inputs.DWG

D-8, C6642-45 Control Panel Drawings, 23 Sample ICP R1S04 Digital Inputs.DWG

D-8, C6642-46 Control Panel Drawings, 24 Sample ICP R1S05 Digital Outputs.DWG

D-9 - Wiring Identification and Labelling

D-10 - Examples of Typical Equipment I/O Interfaces

Section E
Controller

1 Introduction

This section describes the requirements for hardware, software, and configuration of the Controllers and Operator Interface Terminals (OIT), as part of standardization for applications in the City of Greater Sudbury water and wastewater facilities.

The intent of this section is to specify standard hardware and configuration requirements for controllers and local operator interfaces, as well as to provide general programming guidelines and standard routines to be used in programming.

The requirements of this section apply to all new and upgrade/improvement projects that involve process control and monitoring.

2 Controller

Controller hardware architecture considerations will start in the very early stages of the design. The selection of specific controller(s) will be established as part of the preliminary design and shown on the preliminary design network architecture drawing. This will allow for the City of Greater Sudbury review and approval prior to proceeding with detailed definitions and specifications, such as development of detailed controller rack layouts and bills of materials, during the detailed design stage.

Controller standards are meant to provide information and guidelines related to acceptable products and solutions based on programmable controllers, and enforce compliance with them on all City of Greater Sudbury water and wastewater projects. The Consultant is required to follow the standards detailed in the following sections of this document, and to bring to the City of Greater Sudbury's attention any questions and/or issues that could affect their compliance with the standards.

Note that the term "controller" and acronym PAC (Programmable Automation Controller), as used throughout the SCADA, Controls & Instrumentation Systems Design Standards' documents, are interchangeable.

2.1 Controller Hardware

The City of Greater Sudbury has standardized on use of the Allen-Bradley Logix family of controllers for implementation in their water and wastewater facilities.

The following sections provide general guidelines, recommendations, and requirements related to hardware selections and configuration. It is ultimately the responsibility of the Consultant to select the controller architecture with respect to the number and size of controller racks, processor memory size, selection and number of I/O and communication modules, etc. to ensure the design suits the functionality defined in the control narrative and P&IDs. If selections provided for a specific project deviate from the standards, the Consultant must fill in the Standards Deviation Request Form, provided in Appendix A-1 of these SCIS Design Standards, and obtain written approval from the City of Greater Sudbury, before proceeding with the detailed design of the proposed solution. As well, controller redundancy requirements will be discussed and agreed upon with the City during the pre-design stage.

2.1.1 Controller Architecture Design, and Platform/Component Selection Guidelines

The ControlLogix based controller architecture is the City of Greater Sudbury standard for all applications for large water and wastewater plants, and for medium to large remote sites where determined by the City.

The CompactLogix based controller architecture is designed to provide a solution for low to medium size applications, such as pump stations and lift stations. The City of Greater Sudbury is to be consulted when determining suitability of CompactLogix for any of their water and wastewater sites.

Generally, in designing modular controller architecture, the following approach is to be followed:

- Select I/O modules, and any specialty modules
- Select communications modules
- Select controller module with sufficient memory for application
- Select chassis with sufficient slots for required modules, plus spare modules
- Select power supplies

2.1.2 ControlLogix Architecture and Components

2.1.2.1 I/O Modules

The ControlLogix family provides a wide range of I/O cards, based on the number of input/output points, supply voltage levels, field side diagnostics, isolation, fusing, etc.

Also, each ControlLogix I/O module mounts in a ControlLogix chassis and requires either a removable terminal block (RTB) or a 1492 interface module (IFM) to connect all field-side wiring. RTBs and IFMs are not included with the I/O modules, and therefore must be specified separately.

The Consultant will make the selections within the listed approved modules, and confirm them with the City of Greater Sudbury prior to completing the detailed design. Again, any suggested deviations or revisions are to follow the standard approval process, as per Section A – General Requirements of the SCIS Design Standards and corresponding Appendices.

Standard I/O card selections are as follows:

Table 19: ControlLogix Standard I/O Cards

ControlLogix	Approved Module	Removable Terminal Block	Description
24 VDC Digital Input	1756-IB16I	1756-TBCH 1756-TBS6H	16 individually isolated inputs
120 VAC Digital Output	1756-OW16I	1756-TBCH 1756-TBS6H	16 individually isolated outputs
Analog Input	1756-IF8H	1756-TBCH 1756-TBS6H	8-channel analog input module (8 differential current or voltage inputs), with HART interface Scaling: User configurable
Analog Input	1756-IF16H	1756-TBCH 1756-TBS6H	16-channel analog input module (16 differential current inputs), with HART interface Scaling: User configurable
Analog Output	1756-OF8H	1756-TBNH 1756-TBSH	8-channel analog output module (8 voltage or current outputs), with HART interface Scaling: User configurable
Specialty Modules	Will be confirmed by the City of Greater Sudbury SCADA Group on case by case basis.		

2.1.2.2 Communication Modules

The Ethernet Industrial (EtherNet/IP) network protocol is the standard for City of Greater Sudbury water and wastewater PAC implementation, for both controller-SCADA network, and for remote I/O networks. The following table provides a list of standard communication cards acceptable for use as part of the ControlLogix architecture. Communication modules selected for specific applications are to be confirmed with the City of Greater Sudbury SCADA Group on every project.

Table 20: ControlLogix Standard Communication Cards

Network Protocol	Module	Description
EtherNet/IP	1756-EN2T	EtherNet/IP bridge for use as an adapter for I/O on remote EtherNet/IP links, and for communication with SCADA
	1756-EN2TR	EtherNet/IP redundant bridge (for use with redundant controller designs only)

2.1.2.3 Processors

ControlLogix processor modules acceptable for City of Greater Sudbury applications are of 1756-L7x series.

The specifications for acceptable ControlLogix processors are as follows:

- User Memory — 4 MB and up (Size to suit application)
- Non-volatile User Memory — The ControlLogix L7x controllers come with 1784-SD1 Secure Digital (SD) card already installed for permanent storage of controller user program and tag data. All programs to be burned to memory card after succesful completion of SAT. The controller will be configured to load from non-volatile memory on powerup.
- I/O — 128,000 digital maximum / 4,000 analog maximum, 128,000 total maximum
- Built-In Communication Port — 1 USB programming port
- Communication Modules — EtherNet/IP communications module is mandatory
- Number of I/O Racks — As required
- Number of chassis slots — 17 slot maximum

2.1.2.4 Racks

A number of different size chassis are available for the ControlLogix platform.

The Consultant will design the sizing requirements to ensure sufficient slots are provided to accommodate for the assigned I/O, communication, any specialty modules, and a spare capacity for future upgrades. The design for installation of the rack(s) in a panel must satisfy all manufacturers' recommended spacing requirements.

For applications for the City of Greater Sudbury water and wastewater facilities, 7, 13, and 17 slot chassis are acceptable.

Physical slot location within the ControlLogix chassis is not critical. However, for consistency, the following layout rules will be applied:

- The processor(s) in the left most slot(s) of the rack, followed by communications cards, followed by digital input cards, followed by digital output cards, followed by analog input cards, followed by analog output cards, and finally specialty cards.
- Spare cards, and spare slots will be allocated such that they are grouped with the corresponding I/O cards (e.g. spare slots for DI will be left between the DI and DO cards in the rack).
- For a ControlLogix controller to control 1756 I/O, the I/O must either be in the same chassis as the controller, or on a local network, i.e. the network that is local to that controller and not part of the City of Greater Sudbury SCADA system Ethernet network. In case of distributed I/O, dedicated local Ethernet/IP communication module(s), in addition to the network Ethernet module for communication with City of Greater Sudbury's SCADA system, will be specified for the main PAC rack, along with the remote adapter(s) for the corresponding distributed I/O chassis.
- If multiple racks are required in a single ICP; distribution of I/O Cards is to follow this standard approach for each rack. Primary rack will have its cards distributed in the order indicated above, each subsequent rack will have its cards distributed in the same order (with exception of processor module): communication card in the left most slot of the rack, followed by digital input cards, followed by digital output cards, followed by analog input cards and followed by analog output cards.

2.1.2.5 Power Supplies

A power supply is required for each ControlLogix chassis. Power supplies are available in two types, redundant and non-redundant.

The Consultant is to review the redundancy requirements with the City early in the design.

Power supply standard sizes are 10 A and 13 A. Consultant will complete the sizing calculations for the selected rack architecture for proper specification of power supply module.

2.1.2.6 Redundancy

For process applications where a controller system redundancy may be indicated, the details of the redundancy requirements, e.g. partial or full redundancy, etc., will be specifically confirmed with the City of Greater Sudbury for each project.

Otherwise, redundant systems are not a requirement.

The Consultant must be aware that there are specific architecture requirements for redundancy. For example, if a fully redundant controller chassis system is required; two synchronized ControlLogix chassis are to be provided with identically specified and located components in each, including one redundancy module, and at least one EtherNet/IP communication module in each chassis.

2.1.3 CompactLogix Architecture and Components

2.1.3.1 Racks

A CompactLogix system acceptable by the City of Greater Sudbury SCIS Design Standards will be based on 5370 PACs, namely 1769-L24ER (e.g. for pump stations), and 1769-L33ER (e.g. for larger lift stations) models. For larger remote facilities (e.g. well sites), CompactLogix L36ERM is the preferred platform.

Each CompactLogix processor has a maximum local I/O expansion modules capacity. This maximum is 4 modules for L24ER, 16 modules (3 banks) for L33ER, and 30 modules (3 banks) for L36ERM.

A CompactLogix system will be panel mounted. The modules separated into multiple banks will be placed horizontally to each other. When configuring the bank layout for the system, the following considerations must be made:

- The controller must always be in the leftmost position in the first bank;
- Each module in a CompactLogix system uses a set amount of backplane memory. The I/O modules' layout is to be selected such that the backplane memory is not exceeded.
- The power supply can be placed anywhere in the bank, with not more than 8 I/O modules on each side of the power supply (less for high power usage modules). The I/O modules must be distributed such that the current consumed from the left or right side of the power supply never exceeds 2.0A at 5VDC and 1.0A at 24VDC.

2.1.3.2 Power Supplies

The standard power supply module for any CompactLogix controller system is:

- 120 VAC 1769-PA4

2.1.3.3 Processors

• User Memory	Depending on application, 750KB - 3 MB
• Standard Processors	1769-L24ER-QBFC1B, 1769-L33ER, 1769-L36ERM
• Non-volatile User Memory	SD card
• Embedded I/O	(L24ER) - 16 IN/16 OUT/4 AI/2 AO/4 HSC
• Number of Local I/O Expansions	(L24ER) - 4 (L33ER) - 16 (L36ERM) - 30
• Built-In Communication Port	EtherNet/IP
• Communication Options	Mandatory: EtherNet/IP

Maximum number of EtherNet/IP nodes that can be included in Logix application project	(L24ER) - 8 (L33ER) - 32 (L36ERM) - 48

2.1.3.4 I/O Modules

The modules mechanically lock together by means of a tongue-and-groove design and have an integrated communication bus that is connected from module to module by a moveable bus connector. Each I/O module includes a built-in removable terminal block with finger-safe cover for I/O connections. As an alternative, interface modules (IFMs), or I/O module-ready cables may be used.

The standard I/O modules for CompactLogix controller system are:

Table 21: CompactLogix Standard I/O Cards

ControlLogix	Approved Module
24 VDC Digital Input	1769-IQ16
120 VAC Digital Output	1769-OW16
Analog Input (HART)	1769sc-IF4IH
Analog Output (HART)	1769sc-OF4IH

2.1.3.5 Communication Modules

CompactLogix 5370 controllers have two EtherNet/IP ports to connect to an EtherNet/IP network (dual port Ethernet/IP). These two ports share the same IP address and are included for possible use in an Ethernet Device Level Ring. Since the City of Greater Sudbury standards do not use an Ethernet Device Level Ring, only one of the ports is allowed to be used, and that will be for controller connection to the City of Greater Sudbury SCADA Ethernet network.

2.2 Controller Software

The City of Greater Sudbury has standardized on controller software product and development methods and program format and structure, for applications in their water and wastewater facilities.

To provide consistency and reliability, and facilitate maintenance and troubleshooting, these standards will be used by any party working on the controller programming for the City of Greater Sudbury (e.g. System Integrator, or any other party in System Integrator's role).

A Process Control Narrative approved by the City of Greater Sudbury must be available prior to starting the programming work. Along with providing and implementing the programming, and the documentation through the comments within the program, the System Integrator will ensure that the Process Control Narrative is updated to reflect the 'as built' status of the program. The design requirements for Process Control Narratives are provided in Section D - Instrumentation & Control System Design of these SCIS Design Standards.

Ultimately, the City of Greater Sudbury is the owner of all software developed for their facilities.

2.2.1 Programming Software Standard

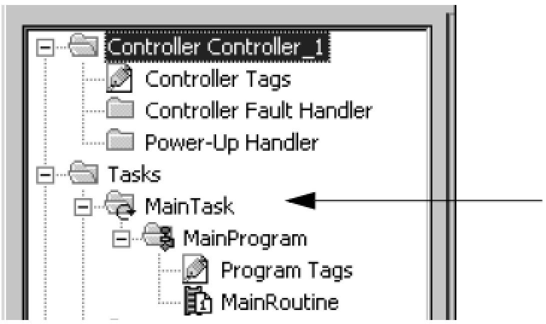
Currently, the City of Greater Sudbury uses RSLogix 5000 Version 20 software as a standard version for PAC programming for its facilities. All City of Greater Sudbury's standard PAC software has been developed and tested for that version. However, the System Integrator must confirm the current RSLogix 5000 version (20) or Studio 5000 Logix Designer version (21 and up) with the City of Greater Sudbury SCADA Group at the time of any specific project, before starting with software development.

The System Integrator will use their own software development licenses to produce the system programs.

All controller software development will be compliant with IEC 61131-3.

2.2.2 Project Folder Structure

Generally, a PAC programming project is comprised of tasks, programs and routines that are organized into a folder structure. This folder structure is referred to as the “Controller Organizer”.



Tasks are divided into programs. Each program contains program tags, a main routine, other routines, and an optional fault routine. Routines provide the executable code for the project. When a task is triggered, the scheduled programs within the task execute to completion from first to last, in the order in which they are displayed in the Controller Organizer. When a program executes, its main routine executes first. The main routine is used to call other routines using the Jump to Subroutine (JSR) instruction.

2.2.3 Baseline Project

For all projects where controller programming will be involved, the standard shell program (controller base program) will be provided by the City of Greater Sudbury SCADA Group. The City of Greater Sudbury standard base program is intended for use for all Logix controller programs prepared for the City, such that standard program structure, and standard approach in development of the logic are followed, in order to provide consistency among the programs, and facilitate maintenance and troubleshooting.

The System Integrator will carefully review the standard base program and routines prior to starting with programming work for a project. If identified, a need for modification of any of the standard programming for application under the specific project’s scope must be communicated to the City of Greater Sudbury SCADA Group through the standard revision approval process stipulated in Section A – General Requirements of the SCIS Design Standards.

The City of Greater Sudbury’s standard controller base line program has a single task configured (Main).

The Main task is configured as continuous task. This task’s Main program contains the following routines:

- Fault Routine & Fault Handling
- Digital Input Mapping

- Analog Input Mapping
- Analog Input Scaling
- Digital Alarms
- Digital Output Mapping
- Analog Output Scaling
- Analog Output Mapping
- Statistics (minimum, maximum, average, totalized, and other calculated values)
- Data Transfer (controller to controller communication)
- Daylight Savings

The Main Program services all controller fault and status information.

The System Integrator will use this baseline project as a basis for developing the controller specific logic application. Automatic control routines and device routines are to be developed/customized for the specific application and included in the Main program under the controller's Main task, after the digital alarms routine.

Each routine call will have a unique enable bit used to enable/disable logic execution within the program.

{CITY WILL PROVIDE INFORMATION ON EACH STANDARD ROUTINE AS REQUIRED}

2.2.4 Programming Guidelines

The following are the general guidelines for development of the controller programming:

- The controller name will be as per approved tag name also referenced in the Process Control Narrative.
- All projects are to be programmed using ladder logic, and starting from the City of Greater Sudbury standard base line program.
- Standard Add-On Instructions and routines will be used where a typical logic is to be used in multiple instances, such that programming of repetitive tasks is avoided. All Add-On Instructions are also to be programmed in ladder logic, but will be deployed in projects in the function block format.
- All projects are to be documented with detailed logic and rung comments.
  - At the beginning of any routine, comments are to be included to clearly describe the purpose and content of the logic provided in the routine.
  - The comment in the main task main program routine is to also include the site and contract names, author's (System Integrator's) name, project revision number and date.
  - Each rung is to be clearly commented, in sufficient detail for future maintenance and troubleshooting.

- All tags in the controller programs must have meaningful descriptions.
- Tag aliasing is not acceptable.
- The default controller-scoped I/O tags created automatically when an I/O module is configured will only be used once in the controller software. These field inputs and outputs are to be mapped to/from internal (buffer) tags.
- The inputs and outputs to/from HMI will also only be used once in the controller software. These inputs and outputs will be mapped to/from internal (buffer) tags.
- To complete Ethernet communications between controllers, the message instruction (MSG) is to be used for controller to controller communications. Only READ instructions are allowed in messaging between controllers.
- The logic will only manipulate the internal tags.
- Only a single instance of a coil within the program is allowed.
- The use of latching coils is not allowed.
- Logic will be written to maintain the equipment in a current state in the event that communication to the processor is lost.
- All Vendor controller programming must be transparent, no proprietary logic will be accepted.
- There must not be any generic logic, which is not applicable to the project, nor any unused tags left in the programs.
- If requested by the City of Greater Sudbury, after the successful software FAT, and prior to implementation on Site, the controller programs for any project will be protected with a security password. As required, a temporary password will be assigned by the City of Greater Sudbury. The temporary password will be requested from the City at the time of software FAT submittal.

2.2.5 Tag Configuration

Tag is a name for an area of the controller's memory where data is stored. Tags are the basic mechanism for allocating memory, referencing data from logic, and monitoring data. The Logix controllers use the tag name internally and do not need to cross-reference a physical address.

A consistent naming structure must be used for all tags. Refer to Section C - Equipment and Data Tagging for details regarding the development of tag names.

The scope of the tag defines which routines can access the data. When a tag is created, it is defined as either a Controller tag (global data) or a Program tag for a specific program (local data).

For the City of Greater Sudbury applications, the following tags must be defined with the scope Controller:

- Tags required in more than one program in the project.
- Tags in a Message (MSG) instruction.

The standard routine tags that communicate with SCADA are defined in the standard shell program with Program scope.

Descriptions for tagnames will also be assigned in a consistent manner. The descriptions are to be provided based on the following guideline:

{Process Area (or Remote Facility), Equipment Description, Signal Description}

2.2.5.1 Data Types

A number of data types are supported by Logix applications. Generally, the following data types will be used:

- REAL for Analog I/O points and floating point numbers
- BOOL for Digital I/O points and logic bits
- DINT for Integers
- COUNTER for Counters
- TIMER for Timers

User-defined Data Types (UDT) are custom created tags where a single tag contains a group of data, and has a corresponding descriptive name, as related to a specific component of the system. Some typically used UDT have been developed by the City of Greater Sudbury SCADA Group, and are included with baseline project. The following are the current standard UDT's:

{CITY WILL PROVIDE INFORMATION ON STANDARD UDT's AS REQUIRED}

2.2.6 Standard Add-On Instructions

City of Greater Sudbury SCADA Group has developed standard Add-On Instructions (AOI), as objects made of reusable code for controller applications in the City's water and wastewater facilities. These AOI are considered a part of the baseline application. As mentioned related to the baseline application, the City of Greater Sudbury SCADA Group must be consulted for the latest version of these standard routines prior to the System Integrator starting software development for a project.

The standard Add-On Instructions will be supplied by the City with security enabled for view only, such that any inadvertent changes to them are prevented. AOI are to be customized to the project-specific inputs and outputs.

Current standard Add-On Instructions are:

- Analog Input Scaling (AIS)
- Analog Output Scaling (AOS)
- Day of the Week (DoW)
- Digital Alarm
- Run Command (RunCmd)

If a requirement for changes to the Add-On Instructions is identified, or a new Add-On Instruction is suggested, it must be communicated to the City through the standard software revision request, and consequently implemented if approved. A revised/new AOI developed for the project will be saved and issued to the City for inclusion in the standard library/baseline application. The new AOI(s) will be provided with associated documentation, in accordance with other standard routines. A revision number, date of issuance, and a revision note is to be included.

2.2.6.1 Analog Input Scaling AOI

{CITY WILL PROVIDE INFORMATION AS REQUIRED}

2.2.6.2 Analog Output Scaling AOI

{CITY WILL PROVIDE INFORMATION AS REQUIRED}

2.2.6.3 Day of the Week AOI

{CITY WILL PROVIDE INFORMATION AS REQUIRED}

2.2.6.4 Digital Alarm AOI

{CITY WILL PROVIDE INFORMATION AS REQUIRED}

2.2.6.5 Run Command AOI

{CITY WILL PROVIDE INFORMATION AS REQUIRED}

2.2.7 Configuration

Configuration settings to be used for each ControlLogix CPU, CompactLogix CPU, communication card, and I/O card will be checked by the City of Greater Sudbury SCADA Group prior to implementation on Site, and specific configuration requirements will be communicated to the System Integrator at that time.

For analog I/O cards, signal scaling parameters will be handled in the standard routines; therefore they will not be in the analog I/O cards' configuration. City of Greater Sudbury SCADA Group will advise of HART configuration requirements for analog I/O channels.

3 Operator Interface Terminals

Panel-mounted SCADA nodes will be a standard feature at remote facilities where permanent operator workstations are not installed.

The required model specification will be based on the following hardware requirements:

- Intel Atom Dual Core 1.6GHz Fanless CPU;
- 19" NEMA-4X Stainless Steel Panel-Mount LCD, high definition resolution 1980x1080, resistive touch screen;
- 2GB DDR2, 64GB SATA Solid State Drive;
- Windows 7 installed and tested;
- External AC Adapter (12V DC), 10/100 LAN, 3 USB 2.0 ports, Audio Ports (Speaker, Microphone, Line In), RS232 Serial Port - DB9.

For software and configuration requirements, refer to Section G - SCADA.

The Consultant will confirm, at the preliminary design stage, the City of Greater Sudbury standard specification for panel-mounted SCADA node, and all related requirements, and include it in the design where applicable.

OITs are often used by packaged system vendors for local panel control. Where required, the City of Greater Sudbury has standardized on the use of Allen-Bradley's PanelView Plus terminals connected directly to the controller through Ethernet. The following minimum requirements are to be met for the PanelView Plus:

- Colour display
- Minimum size 10.4", with display area 8.3" x 6.2" or larger
- 640 x 480, 18-bit resolution
- Standard 64 MB RAM / 64 MB Flash
- Ethernet communication port
- 2 USB communication ports

4 Submittals

Several submittals, involving hardware and software related to the scope of this section of SCIS Design Standards are required throughout the course of a project. Refer to the summary of deliverables included in Section B - Automation System Project Delivery, Appendix B-1.

Section F
Networks and Communications

1 Introduction

1.1 General

The intent of this document is to provide standards and guidelines for use by Consultants for the design, expansion or upgrade of SCADA infrastructure within the City of Greater Sudbury water and wastewater facilities.

The City of Greater Sudbury infrastructure is widely dispersed. The SCADA system and controllers communicate with equipment at operations sites located throughout the City of Greater Sudbury.

The SCADA control system includes a local area network (LAN) that links the SCADA within the site and also a wide area network (WAN) that links the operations remote sites to the central operations control sites.

The City of Greater Sudbury has established the approach and arrangements for upgrades of their water and wastewater WAN outside of the scope of this Standard document. The scope of this Standard applies only to LAN architecture within water and wastewater facilities. This standard assumes that the provisions for connection to the City of Greater Sudbury's WAN will exist at every Site at the time of any Consultant's project related to the specific Site. References and details related to the City of Greater Sudbury's WAN found in this Standard are only provided for general understanding of the overall system. Any additional information and special requirements will be included in the specific project assignment issued by the City of Greater Sudbury.

1.2 Industry Standards

Industry standard documents related to the scope of this document include, but are not limited to:

1. TIA/EIA-568-C: Telecommunications Cabling Standard
2. TIA/EIA-569-B Commercial Building Standards for Telecommunications Pathway & Spaces
3. Ontario Electrical Safety Code, Section 56 - Optical Fibre Cables
4. Ontario Electrical Safety Code, Section 60 - Communication
5. TIA/EIA-606: Administrative Standard for Telecommunications
6. TIA/EIA-607: Grounding and Bonding Requirements for Telecommunications in Commercial Buildings

1.3 Definitions

The following are some common industry terms and acronyms related to the scope of this Section, regardless of whether they are used elsewhere in this document or not. Being specialized, most of these acronyms and terms have not been included in the common list of acronyms in Section A of the SCIS Design Standards, but kept specific to this Section.

Campus Layout Drawing	A drawing showing location of all network equipment and network cabling runs on a site plan.
Network Architecture Drawing	A drawing showing the interconnections between network equipment and all other devices residing on the network.

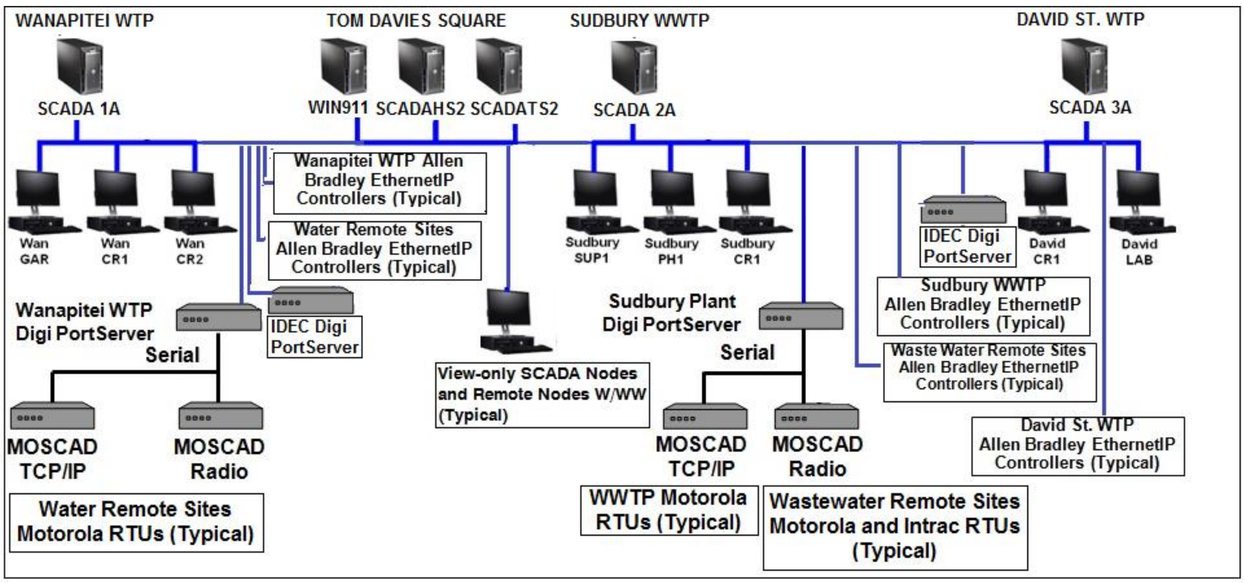
EIGRP	Enhanced Interior Gateway Routing Protocol is a dynamic routing protocol by which routers automatically share route information for handling of network traffic.
IP	Internet Protocol (IP) is the primary communications protocol used for communicating data across a packet-switched internetwork using the Internet Protocol Suite, thus establishing the Internet IP; it has the task of delivering packets from the source host to the destination host based on the IP addresses in the packet headers.
MAC	Media Access Control Address (MAC address) is a unique identifier assigned to a network interface for communications on the physical network. MAC addresses are usually assigned by the manufacturer of a network interface controller (NIC), and are stored in its hardware.
Neutral Zone	A physical or logical sub-network that contains an organization’s external services to a larger, untrusted network, usually the Internet. The purpose of a neutral zone is to add additional layer of security to an LAN.
MDLC	A 7-layer communication protocol used by Motorola MOSCAD RTUs
NIC	Network Interface Controller or Network Interface Card is a computer hardware component that connects a computer to a computer network (also known as network/LAN adapter).
OSI	Open Systems Interconnection
QoS	Quality of Service is the overall performance of a computer network, evaluated based on error rates, bandwidth, throughput, transmission delay, etc. It refers to the ability to provide resource reservation control, such as different priorities to different applications, users, or data flows, etc.
SNMP	Simple Network Management Protocol is an Internet-standard protocol for managing devices on IP networks
TCP	Transmission Control Protocol, one of the core protocols of the Internet Protocol suite; the entire suite is typically called TCP/IP. The protocol corresponds to the transport layer of TCP/IP suite - it provides a communication service between an application program and the Internet Protocol (IP).
VLAN	Virtual Local Area Network
VPN	Virtual Private Network
WAN	Wide Area Network

2 SCADA Network Architecture

The earlier City of Greater Sudbury WAN SCADA Architecture consisted of a mix of Ethernet/IP networks, along with MOSCAD TCP/IP, MOSCAD Radio, IDEC Radio and Bristol Babcock serial communications, which were connected to the City of Greater Sudbury Ethernet network via the Wanapitei WTP and Sudbury WWTP Digi Port Servers.

Although the current architecture still relies on some of the interfaces and protocols mentioned above, the City of Greater Sudbury standard for current and future WAN SCADA Architecture is based on Ethernet IP. By applying the Ethernet standard throughout the system, the City of Greater Sudbury is moving to a more reliable communications network and also reducing the investment in costly proprietary systems.

The following is a conceptual representation of the City of Greater Sudbury's water and wastewater SCADA network architecture.



The City of Greater Sudbury Network is based on single mode fibre. Within facilities, the fibre network is owned by the City.

Motorola MOSCAD Remote Terminal Units (RTUs) are currently used in multiple remote sites for two way wireless data communication. MOSCAD is a microprocessor-based RTU with large memory capacity that can make control decisions on-site based on status conditions and values from local and remote sources. MOSCAD uses the OSI-based MDLC communication protocol for all data signaling. Multiple 3rd-party protocols are also supported. MDLC was specifically developed for two-way radio use but is completely applicable to microwave, and other media. It permits large volumes of data to be quickly transferred between terminals using packet transmission techniques.

2.1 Operations Sites

The two categories of operations sites are:

- Central Sites - operations sites that are regularly staffed. These are typically larger sites and are responsible for the operational control of other smaller operations sites. The entire water system is primarily monitored at the Wanapitei Water Treatment Plant, while the wastewater system is primarily monitored at the Sudbury Wastewater Treatment Plant. (Both water and wastewater systems can be monitored from both sites.)

- Remote Sites - unmanned operations sites are typically small sites that are linked to a larger centralized operations site.

The location information (physical addresses) and IP address listing of all operations sites are to be maintained by the City of Greater Sudbury and up-to-date information from this listing be provided to participants who expand, upgrade, install, operate and maintain the City's SCADA, Controls and Instrumentation systems, to understand the overall interconnections before undertaking changes. Appropriate information for specific sites will be provided by the City of Greater Sudbury to the successful proponent, as applicable to the specific project's scope.

The respective Consultant, or other party whose project is making an addition, deletion or change to the City of Greater Sudbury's SCADA, Controls and Instrumentation systems, will ensure that the City of Greater Sudbury's SCADA representative is fully informed of, and in agreement with the design for the changes to be made. As well, any new hardware or application intended by Consultant's design to be put on the City of Greater Sudbury's network, must be clearly brought to the City's attention for approval prior to finalizing the design. Any network device is to have SNMP capability for remote diagnostic.

When a change or update is completed for an operations site location, a corresponding update must be made to the SCADA System Architecture Master, by the City of Greater Sudbury's staff, and the corresponding figure included in this Standard must be updated accordingly at that time.

2.2 Central Sites

At water and wastewater treatment plants, a campus style Ethernet network design is required. This follows a hierarchical star topology that contains:

- A main equipment room, with the network main access switch housed in a main network access closet.

- Backbone cabling from the main network access closet which contains an Ethernet access switch, radiating out to Ethernet access switches located in field ICP panels. Single mode fibre or CAT6 cabling is used between the main switch and the switches in the field ICPs, depending on the distance and on ambient properties. Single mode fibre (not CAT6) is always to be used for network cabling between buildings.

- CAT6 horizontal cabling from ICP panels' access switches to end devices, such as controllers, SCADA workstation, and other Ethernet IP devices (e.g., VFD's, power monitors, security cameras).

2.3 Remote Sites

All small remote unmanned facilities require a network connection to the City of Greater Sudbury's wide area network backbone to allow data communications and access from the City's water and wastewater facilities.

A combination of fibre links and radio links are used to connect the remote sites to the central sites which are responsible for their operational monitoring and control.

For all future upgrades, Ethernet services will be used. The City of Greater Sudbury's intent is to upgrade the existing radio sites to fibre-optic where feasible or, where not feasible, to upgrade to a new, Ethernet based radio system.

2.4 Redundant Core Network Switches

City of Greater Sudbury uses commercial grade, managed network core, access switches, and fibre transceivers in all facilities. Core switches are located at Wanapitei and Kelly Lake and these provide redundancy in switching and routing to remote sites.

3 Local Area Network

This section applies to design of the communication networks at the City of Greater Sudbury water and wastewater treatment sites.

A Consultant on any project that involves additions/modifications to the local area network at the City of Greater Sudbury water and wastewater facilities will follow the guidelines and standards from the following sections when specifying the network components, and network installation, testing and performance requirements.

3.1 Performance Requirements

The end-to-end response time for the SCADA network is to be designed for a maximum of one (1) second.

The LAN network within facilities is to be designed to meet the following minimum performance requirements:

- 10/100 BASE-T(X): field devices including PACs, OITs, power monitors and all in-plant CAT6 backbone cabling connections.
- 100BASE-FX: applies to fibre-optic cabling within facilities.

3.2 Structured Network Cabling

The City of Greater Sudbury fibre/radio WAN-related design and upgrades are handled by the City's agreement with a dedicated provider; therefore, WAN design will be outside of the Consultant's scope on a typical water and wastewater (upgrade) project.

For the intent and scope of this Standard, it is to be assumed that the communications connection to the City of Greater Sudbury WAN will be available at all Sites, as completed by the City's external provider, and terminated in the main network access closet, housing the WAN communication equipment. Distribution switches and routers connect directly to the main access switches.

A Consultant on any project will be responsible for the design of network upgrades within the affected facility, based on the following approach:

- The network backbone cabling radiates out from the main access switch to the field access switches (located in ICPs). The backbone cabling is either a fibre-optic cable, or a Category 6 (CAT6) copper cable.
- The horizontal cabling runs from network access switches in the ICPs to end devices. The horizontal cabling is based on CAT6 copper cabling. There could be existing Ethernet devices connected directly to the main access switch (e.g. SCADA workstations, cameras) by CAT6 horizontal cabling. However, PACs, workstations and field end devices designed by the Consultant will not be connected directly to the main access switches.
- All network cabling for the scope of a project will be specified for execution by the construction Contractor. However, all construction work, including testing, must be done by a certified installer. Specific to fibre cabling, the Consultant will coordinate with the City of Greater Sudbury, in early stages of detailed design, whether the City's preferred (pre-selected) provider(s) is to be specified (to be carried by the Contractor), and if so, obtain the provider's quotation for the required scope of work, for proper inclusion in construction Contract budget.

3.3 LAN Network Components

3.3.1 Fibre-Optic Cable

Fibre-optic cable is to be used for backbone cabling segments between the facility's main network switch(es) and the access switches in ICPs when the cable runs are between buildings, and/or through high-EMI environments, and/or at distances longer than 90 m. For fibre-optic cabling, single mode fibre will be provided. The fibre supplier is to be determined in consultation with the City of Greater Sudbury, as indicated in the Structured Cabling section of this Standard.

Fibre-optic cabling is to be terminated with single-mode duplex LC connectors. The single mode fibre-optic cable must meet the performance requirements of the TIA/EIA-568-C.3 specification. The Consultant will confirm a cable manufacturer and model preferred by the City of Greater Sudbury at the early stage of detailed design.

The Consultant will specify all fibre-optic cable, connectors and appurtenances that make up the backbone cabling segments.

The fibre-optic cable must meet or exceed (depending on specific application) the following minimum requirements:

- Indoor/outdoor rating;
- Core-locked;
- 9/125 micron Core/Cladding (single-mode);
- Riser-rated (FT4) for cable runs in conduits, and plenum-rated (FT6) otherwise;
- Inner and outer PVC jackets;
- 12 fibre strands;
- Tight-buffered armour (for locations where rodents are a known issue, and which can be removed as required, leaving the inner cable suitable for any other indoor/outdoor application);
- All connectors for the termination of the fibre-optic backbone cable are to be duplex LC connectors. 6 strands are to be terminated; only 2 strands are to be used.

Fibre-optic LC connectors must meet or exceed the following minimum requirements

- 9/125 micron with a ceramic, pre-radiused ferrule
- Typical insertion loss must be less than 0.2dB, maximum 0.5dB, and reflectance must be less than -55dB.
- The connectors must be used with preloaded LC duplex adapters.

Fibre-optic patch cords are to be factory assembled and tested by the manufacturer. The patch cords will be a two fibre strand cable of the same type as the fibre-optic backbone cabling.

3.3.2 Copper Ethernet Cable

Unshielded twisted pair (UTP) CAT6 copper Ethernet cable will be used for backbone cabling between the facility's main network access switch and the network switches in ICPs, when the cabling runs within a building, where the environment is suitable, and at distances shorter than 90 m.

CAT6 copper Ethernet cable will also be used for horizontal cabling between the access switches in ICPs, and the end devices, such as PACs, SCADA workstations, VFD's, power monitors, etc.

The CAT6 cable must meet the requirements of the TIA/EIA-568-C specification for this category. Consultant is to ensure that copper network cabling is only specified to be used for runs where UTP CAT6 cable, which is the City of Greater Sudbury's standard, were acceptable for the application. The CAT6 UTP cable will be specified with all required connectors and appurtenances, and to be installed in cable trays or rigid conduit, based on the specific site/area conditions and in accordance with the cable manufacturer's recommendations. The CAT6 cable must meet the following minimum criteria:

- Constructed from 0.57mm (23AWG), bare copper wire insulated. Two insulated conductors twisted together to form a pair and four pairs laid up to form the basic unit.
- Jacketed in flame-retardant PVC. Cable run in conduit must meet or exceed FT4 rating. Cable not run in conduit must meet or exceed FT6 rating.
- Tested up to 250 MHz with a guaranteed performance that meets or exceeds the TIA/EIA-568-C.2 for CAT6 for relevant parameters.
- All CAT6 cable connectors must be unshielded modular jacks, wired for T586A wire map.

Copper Ethernet patch cords are to be factory assembled and tested by the manufacturer. CAT6 UTP patch cords are to be used.

3.4 Installation Methods

Fibre-optic and copper backbone cabling can be run in cable trays, rigid conduit, or corrugated HDPE conduit, depending on the cable route and installation environments. For example, rigid PVC conduit must be used in corrosive environments.

Horizontal CAT6 cabling is to be run in rigid conduit.

Related to installation of the network cabling and associated pathways, the following general guidelines should be taken into consideration, and addressed in the Consultant's specifications and followed during construction:

- Installation of the fibre-optic backbone cable must comply with Section 56 (Optical Fibre Cables) of the Ontario Electric Safety Code and the EIA/TIA-568-C Telecommunications Building Standard.
- Each fibre-optic cable segment is to be a continuous run (no splices) from the network main access switch to the ICP housing the target access switch. A 1-metre loop will be left at the end of each fibre-optic cable and housed inside the ICP.
- The tensile load for fibre optic backbone cable must not exceed the manufacturer's recommended maximum tensile load. To minimize cable tension, fiber optic cable pull boxes are to be provided at strategic points, such that the cable is pulled as a continuous run through no more than two 90° bends or their equivalent (e.g., one 90° bend and two 45° bends). Bend radius must not go below the manufacturer's specified minimum.

- Make only gradual bends in the CAT6 UTP cable where necessary, to maintain the minimum bend radius of 4 times the cable diameter.

- For long backbone cable runs within buildings, especially for cabling under galleries, metal cable trays are the preferred pathway.

- Rigid conduit is to be utilized to bridge gaps between sections of cable tray, and between the end panels and the corresponding cable tray. Each transition between cable tray and conduit is to be smooth enough to ensure that the cable bend radius does not compromise the manufacturer's recommended minimum bend radius. Cable bend supports shall be used during pulling to ensure minimum bend radius.

- Cabling tray/conduit routes should be selected to avoid beams, columns and other obstructions.

- Conduit and cables should be installed to avoid proximity of water and heating pipes. Any conduit containing copper Ethernet cable must be kept away from copper heating pipes and any sources of electrical interference.

- Conduit should be mounted above other piping where possible in parallel rows, parallel or perpendicular to walls and ceilings.

- CAT6 UTP cables run in a cable tray are to be kept as far away from potential sources of EMI (electrical transformers, light fixtures, power cables) as possible; at least 300 mm separation from power cables shall be maintained.

- Conduits and ducts through floors and walls are to extend 50-75 mm past the finished surface.

- Where conduit exists between rooms, fire stopping must be used to seal any cavities surrounding the conduit.

- All conductive trays and conduits are to be grounded on the building level/floor where the cable pathway is installed.

- Specify conduits and cable trays large enough to allow for the correct conduit fill ratio (approx. 40-50%).

3.5 Components and Cable Identification

All network cables are to be identified with durable non-fading wire markers. Labels for cables are to be laser-printed, self-laminating, adhesive, polyester (indoor/outdoor). Lettering for the labels is to be black on a white background with a minimum character height of 4mm. Hand-written labels will not be accepted. In the event that wall outlets are to be used, the outlet must be labelled the same as the cable.

All network cables are to be labeled at both ends of the cable, as well as at each transition. A transition is defined as: a change in ducting (e.g. cable tray to conduit), a change in direction of more than 45 degrees, or an entrance and exit of ducting through a wall or floor. If the fibre cable is run in conduit then the transition labels will be applied to the conduit.

The tagging convention for identification of network cables requires both the source and the destination of the cable to be indicated on the label.

All pathways (cable tray or conduit) carrying backbone cable will be tagged as “LAN BACKBONE”.

3.6 Factory Acceptance Testing

As part of the witnessed Factory Acceptance Test (FAT) of ICP enclosures, the City of Greater Sudbury SCADA representative will verify the construction of the panel with respect to provisions for network components, and panel as-built drawings and bill of material. The network switch to be housed in the panel will be free-issued. The Consultant will confirm the lead time with the City, such that it is properly specified for the Contractor, to request the switch in accordance with scheduling of construction activities.

Note: The term “free-issued” refers to equipment supplied by the City of Greater Sudbury.

3.7 Post-installation Cable Testing

All single-mode fibre-optic cabling strands and all CAT6 copper Ethernet cabling shall be tested by the Contractor. The Consultant will specify all testing requirements. Testing should be done when all or most of the possible sources of interference are active/running.

3.7.1 Fibre-Optic Testing

Upon installation, all single-mode fibre-optic cabling strands are to be tested by the City of Greater Sudbury approved qualified installer who completed the installation works. All testing must be scheduled and completed under the Contractor’s scope and coordination.

Testing will be performed on each cabling segment (connector to connector).

Link attenuation will be tested in accordance with TIA/EIA-526-7, method A.1. Optical loss is to be measured on each single-mode fibre strand at 1310 nm. Loss on each fibre strand will be measured from each direction (bi-directional). Link attenuation will not include any active devices or passive devices other than cable and connectors.

Fiber links will be tested at the appropriate operating wavelengths for anomalies, and to ensure uniformity of cable attenuation and connector insertion loss.

For a tested fibre-optic strand to be considered “passed” it must meet or exceed the permanent link and performance requirements specified in the TIA/EIA-568-C.3 for 9/125 micron single mode fibre.

Link length will be measured optically.

The Contractor will be responsible for all fibre-optic testing equipment and co-ordination of testing.

The testing equipment will meet the following minimum criteria:

- All test equipment will be from the same manufacturer, and will have a proof of recent calibration in accordance with manufacturer’s requirements. Acceptable test equipment manufacturers are Fluke, HP, or MicroTest.
- For single mode optical fiber light source, for Optical Loss Test Set (OLTS), dual laser light source with central wavelength of 1310 nm will be provided, with minimum output power of –10 dBm. Optical loss test results will meet the standards of ANSI/TIA-568-C.0.
- Power meter for 1310nm wavelength with maximum uncertainty of ± 0.25 dB.
- Single mode Optical Time Domain Reflectometer (OTDR).
- Fibre microscope for visual inspection, with minimum 200X magnification.

- Testing of the cabling will be performed using high-quality test cords of the same fiber type as the cabling under test. The test cords for OLTS testing will be between 1 m and 5 m in length. The test cords for OTDR testing will be approximately 100 m for the launch cable and at least 25 m for the receive cable.

- Test equipment software will be Windows based, with built-in statistical analysis, and built-in export to PDF capability. Test equipment must be capable of storing full data for all tests.

Upon completion of testing, the Contractor is to submit to the City a detailed Fibre-Optic Cable Test Report, including the following information for each fibre-optic strand tested:

- The identification of the Site, and the date and time of the test;

- Test equipment manufacturer, model, serial number, last calibration date, and software version;

- Cable and fibre ID number;

- Number of mated connectors;

- OLTS attenuation link and channel measurements at the appropriate wavelength (1310nm), and the margin, i.e. the difference between the measured attenuation and the test limit value;

- Actual length of each optical fibre;

- The index of refraction used for length calculation when using a length capable OLTS;

- OTDR link and channel traces and event tables at the appropriate wavelength;

- The length for each optical fiber as calculated by the OTDR;

- Overall PASS/FAIL indication.

3.7.2 Copper Ethernet Testing

All CAT6 copper Ethernet cabling must be tested by the Contractor. For a tested CAT6 cable to be considered “passed” it must meet or exceed the permanent link and performance requirements specified in TIA/EIA-568-C.2. The Contractor will be responsible for providing all necessary CAT6 cable testing equipment. The testing equipment will meet the following minimum criteria:

- All test equipment is to be from the same manufacturer, and is to have a proof of recent (<12 months) calibration. Acceptable test equipment manufacturers are Fluke, HP, or MicroTest.

- Test adapters must be approved by the manufacturer of the test equipment. Adapters must meet the requirements for NEXT, FEXT and Return Loss in accordance with ANSI/TIA-568-C.2.

- Baseline accuracy of the test equipment must exceed TIA Level III, as indicated by independent laboratory testing.

- Test equipment must have measuring capabilities for the parameters listed above, and be capable of certifying CAT6 UTP to TIA/EIA-568-C standards.

- Test equipment software is to be Windows based, with built-in statistical analysis, and built-in export to PDF capability. Test equipment must be capable of storing full frequency sweep data for all tests.

- The measurement reference plane of the test equipment is to start immediately at the output of the test equipment interface connector. There must not be a time domain dead zone of any distance that excludes any part of the link from the measurement.

The Contractor is to submit to the City a detailed CAT6 Cable Test Report which will include the following information:

- The identification of the Site, and the date and time of the test
- The manufacturer, model and serial number of the field-test instrument, the factory calibration date
- Circuit ID number and Cable ID.
- Date and time of test.
- The version of the test software
- The adapters used
- Wire Map
- Propagation Delay values, for all four pairs
- Delay Skew values, for all four pairs
- DC Resistance values, for all four pairs
- DC Resistance Unbalance, values for all four pairs
- Insertion Loss, worst case values for all four pairs
- NEXT (Near-End Crosstalk), worst case margin and worst case values, both directions
- PS NEXT (Power Sum Near-End Crosstalk), worst case margin and worst case values, both directions
- ACR-F (Attenuation to Crosstalk Ratio Far-End), worst case margin and worst case values, both directions
- PS ACR-F (Power Sum Attenuation to Crosstalk Ratio Far-End), worst case margin and worst case values, both directions
- Return Loss, worst case margin and worst case values, both directions
- TCL (Transverse Conversion Loss), worst case values both directions
- ELTCTL (Equal Level Transverse Conversion Transfer Loss), worst case values, both directions.
- Time Domain Crosstalk data if the link is marginal or fails
- Time Domain Reflectometer data if the link is marginal or fails
- The overall Pass/Fail evaluation of the link-under-test

3.7.3 Link Testing and Site Acceptance Testing (SAT)

Following the installation of all ICP enclosures and networking equipment, and once the field network cabling testing has been successfully completed (with PASS mark) and all testing reports submitted for review by the Contract Administrator and the City of Greater Sudbury, the City of Greater Sudbury will perform link testing, where all the devices must be successfully “pinged”, without a loss of packets.

The City of Greater Sudbury representative also maintains the right to select a random sample of the installed links and test those links. The results obtained will be compared to the data provided by the installation contractor. If more than 2% of the sample results differ in terms of the pass/fail determination, the installation contractor must repeat 100% testing at no cost to the City of Greater Sudbury.

Final Site Acceptance will be subject to completion of all work, successful post-installation testing which yields 100% PASS rating, receipt of the Cable Testing Results Report, and successful link testing.

4 Submittals

The Consultant will prepare a LAN network specification and drawings for the scope of a specific project, based on the guidelines provided in this Section of the City of Greater Sudbury SCADA, Controls and Instrumentation Systems Design Standards. Design and construction submittals are to be provided in accordance with submittal requirements of Section B, and Appendix B-1.

A sample Consultant's network architecture drawing is included in Appendix F-1.

4.1.1 Network Contractor Documentation Submittals

All submittals required from the Contractor during the construction stage are to be specified by the Consultant.

Submittals prior to execution of the tests:

- Manufacturers' catalog sheets and specifications for the cabling and all required appurtenances, for all fibre-optic and CAT6 cabling.
- Manufacturers catalog sheets and specifications for the test equipment for fibre-optic and CAT6 cabling.
- A schedule (list) of all optical fibers to be tested.
- Manufacturers catalog sheets and specifications for fiber optic field-test instruments including optical loss test sets (OLTS; power meter and source), optical time domain reflectometer (OTDR) and inspection scope.
- A schedule (list) of all balanced twisted-pair copper links to be tested.
- Sample cable test reports (for approval of format and content in advance of Contractor's testing).

After execution of the tests, the following is to be submitted:

- Fibre-Optic Cable and CAT6 Test Results Reports in both hardcopy and electronic formats. The test result records saved within the field-test instrument must be transferred into a Windows-based database utility that allows for the maintenance, inspection and archiving of these test records.
- As-built drawings will include, but will not be limited to block diagrams, cable labeling, cable termination points, as-built network architecture drawing and campus layout drawing(s). The as-built drawings will include all field changes made up to construction completion.

All documentation indicated above is to be included in the Contractor's Operation and Maintenance manuals.

F-1 Sample Network Architecture Drawing

Section G
SCADA

1 Introduction

This section describes the requirements for hardware, software, and configurations of the SCADA system, as part of standardization for applications in the City of Greater Sudbury water and wastewater facilities.

The section includes requirements for SCADA software, such as the standard software package, standards for application settings, communication drivers, security, etc. It also provides guidelines for application development, including, but not limited to file structure and naming, display development, linking of graphics, alarming.

The requirements of this section apply to all new and upgrade/improvement projects that involve process control and monitoring.

2 SCADA

The City of Greater Sudbury has standardized on SCADA architecture for its water and wastewater system of treatment plants and remote sites, and on guidelines for solutions to be provided for integration of new projects for the City's water and wastewater facilities with the existing SCADA system.

The objectives of this standardization are to establish common hardware and software requirements, and to guide application development towards a common look and feel, to provide standards for data logging and integration of historical repositories, to increase productivity, and make maintenance of the system efficient and, as much as possible, trouble-free.

2.1 Standard SCADA Architecture

The City of Greater Sudbury SCADA System infrastructure is widely dispersed, and is based on wide area network (WAN) and local area networks (LANs) for interconnections among numerous locations within the system.

Overall, the system has two centralized SCADA operational and control sites. The water systems are monitored at the Wanapitei Water Treatment Plant, while the wastewater systems are monitored at the Sudbury Wastewater Treatment Plant. However, both systems can be monitored from either location.

A third plant, the David St. Water Treatment Plant, operates in conjunction with, but independently from the other two main sites.

2.2 SCADA Hardware

2.2.1 General

Standard server grade machines are used for the server applications, configured based on the application requirements, and running Microsoft Server OS. The servers are installed in locked enclosures in the Plants.

All SCADA servers are installed with redundant Network Interface Cards (NICs) but currently only one channel of each NIC is used.

Microsoft Windows 2008 Server Standard R2 x64 operating system is used as an environment for iFIX application on all SCADA servers. View nodes are typically running Microsoft Windows 7 platform.

Generally, SCADA hardware specifications will be maintained and updated as required by the City of Greater Sudbury. The current standard SCADA computer hardware configuration specification is included in Appendix G-1.

For any SCADA computer hardware to be provided for a specific project, the Consultant will confirm with the City of Greater Sudbury SCADA Group the current hardware specification and configuration requirements, or if the hardware will be free-issued to the Contractor during construction, for inclusion of proper requirements in the tender documents.

Note: The term “free-issued” refers to equipment supplied by the City of Greater Sudbury.

The following is a summary of the main elements of current SCADA architecture, for reference and guidelines related to system upgrades that may be required under different projects' scopes.

2.2.2 SCADA Servers

2.2.2.1 Wanapitei WTP SCADA Architecture

Servers

SCADA1A Main Water Control Server (iFIX V5.5)

2.2.2.2 David Street WTP SCADA Architecture

Server

SCADA3A David Street WTP Control Server (iFIX V5.5)

2.2.2.3 Sudbury WWTP SCADA Architecture

Server

SCADA2A Sudbury WWTP Control Server (iFIX V5.5)

2.2.2.4 Tom Davies Square SCADA Architecture

SCADATS2 running iFIX v5.5 is currently in service. All view-only nodes and remote nodes for Water/Wastewater, Engineering, IT, City of Greater Sudbury are linked to this server. Contingencies are in place for the deployment of SCADATS3 should the need for additional SCADA nodes exceed the capabilities of SCADATS2. These servers are located on the 2^{nd} Floor at Tom Davies Square (TDS).

SCADAHS2 (iFIX Historian) is in the same location. This server will be used as the main SCADA data collector. Historian collector exists on each server, and it forwards the data to the iHistorian server (still not fully in place)

Also, at this location is the WIN 911 server. WIN 911 is a software program that is installed into the SCADA system and is configured to call staff via an iPhone when an alarm occurs. This takes place via Apple Push Notifications.

2.2.2.5 I/O Servers

The three main process I/O servers are SCADA1A, SCADA2A, and SCADA3A, which are used for process control only.

2.2.3 SCADA Workstations

SCADA workstations are the Plant Operator view nodes, providing the means of human-machine interface (HMI). They are located in plant control rooms, local process areas and remote sites. Generally, the larger plants have a control room equipped with SCADA workstation(s), and distributed workstations inside different process areas. Manned remote sites generally have a single workstation.

2.2.4 Miscellaneous Visualization Nodes

In addition to the workstations and servers, the Operations staff may have tablet and/or laptop computers for use as visualization nodes.

2.3 SCADA Software

The SCADA system provides operators with a means of monitoring and controlling plant operations.

The following sections are intended to provide guidelines related to SCADA software versions, configuration, graphics objects development, colours, Visual Basic (VB) scripting, alarm and event management, and other software configurations related to the programming for the City's SCADA system. The Consultant will follow these guidelines when specifying the SCADA programming scope of work.

2.3.1 Application Software Standard

The City of Greater Sudbury has standardized on the use of GE Proficy iFIX software for the SCADA development and runtime environments.

Currently, the City of Greater Sudbury has established iFIX Ver. 5.5 as a standard version for all future SCADA development for its facilities.

Generally, the System Integrator must confirm the current iFIX version, and the Software Improvement Modules (SIMs) and service packs (SPs) that are to be installed with it, with the City of Greater Sudbury SCADA Group at the time of any specific project, before starting with software development.

2.3.2 Communication Protocol

The City of Greater Sudbury has standardized on OPC communication protocol (Open Platform Communications/OLE for Process Control) for connecting the SCADA application with process control hardware. Specifically, KEPServerEX v5.8 is used as the standard interface between SCADA severs and controllers.

2.3.3 SCADA System Configuration

2.3.3.1 System Configuration Utility

SCADA Application settings are defined through System Configuration Utility (SCU). The following are the details of the standard configuration settings.

Paths

The system tree that appears within iFIX workspace shows a hierarchical display of applications and folders. Associated with each application and folder in the system tree is an iFIX path. These paths show where the files reside and are defined in the System Configuration Utility (SCU).

Alarms Configuration

Alarm Services are to be enabled on SCADA nodes as per the defaults below:

- Alarm Summary Service (Manual Alarm Deletion)
- Alarm History Service
- Alarm Network Service
- Alarm Start-up Queue Service

Alarm Areas have been assigned for the grouping of alarm tags based on process areas or remote facilities.

Network

The network configuration varies depending on the type of SCADA node. View nodes are configured to access all servers for the display of all relevant process and control information available through the SCADA system.

For details of the City of Greater Sudbury SCADA network architecture, refer to Section F – Networks and Communications of SCADA, Controls & Instrumentation Systems Design Standards.

Security

Security is to be enabled on all SCADA nodes.

Each user of the SCADA system has a user name and password for access. The users are members of one or more security groups, which are configured as part of the security hierarchy within the SCADA system. The security groups have security areas assigned to them, allowing authorized users to access tags.

The City of Greater Sudbury SCADA Group is responsible for the updates in the security configuration files.

Tasks

HTC.EXE (Classic Historian)

RUNTASK.EXE (Used to delay startup schedules)

MAPNOTES.EXE (Used to map operator Site Notes)

2.3.3.2 Visual Basic (VB) Scripting

VB Scripting is used in programming of navigation buttons, and pop-ups manipulation. For all standard, pre-configured scripting, refer to the baseline application.

2.3.4 SCADA Application Development Guidelines

For consistency in SCADA programming among projects and facilities, the City of Greater Sudbury has a template application which includes samples of displays, equipment graphics and VB scripts. Standardization has been provided related to equipment graphics, colours and pop-up displays to provide consistency throughout the SCADA interface.

For the Consultant's understanding when specifying the scope of work for the System Integrator, the following sections describe the elements of the standard SCADA base line application. The actual base line application is to be requested from the City of Greater Sudbury SCADA Group before initiating any SCADA programming.

2.3.4.1 File Naming Convention

For most sites, the following filename sections are used:

W	Water Site
WW	Wastewater Site
BS	Booster Station
Dist	Distribution
DS	David St. WTP
DSZ	David St. WTP Zenon Section
Menu	Navigational Menu
Storage	Water Storage Tanks and Reservoirs
Tools	Miscellaneous Tools
VC	Valve Control
Wanapitei	Wanapitei WTP
Wells	Well Sites
LS	Wastewater Lift Station
PLT	Wastewater Plant
RT	Rock Tunnel Site

2.3.4.2 Data Base Configuration

Analog tags are used to read and write integer or floating point values such as well levels or alarm set points. Digital tags are used to read and write discrete data such as start/stop values or alarm conditions.

Scan time of SCADA database tags is to be adjusted for vital data to be polled faster than less critical data, such that the overall server workloads and performance are optimized. The default scan time for critical data is one scan per second. Also, the parameters of I/O server communications are to be adjusted with respect to channels configuration, timing settings, etc.

These settings are fine tuning parameters and currently not standardized. The intended settings must always be discussed with the City of Greater Sudbury SCADA Group before being finalized by the System Integrator.

2.3.4.3 Display Structure

The City of Greater Sudbury has standardized on SCADA display types and layout. The complexity of any project (site/process) will determine the number and types of displays to be developed for that site.

Typical types of displays are:

- Plant overviews

- Process areas' and remote sites' overviews
- Process statistics screens
- Trend screens
- Facilities' (remote sites') alarm screens and Master alarm screens
- Control pop-ups for equipment mode and status control, in-out of service ("lock-out" control), duty selection, etc.

The upper part of all process and trend screens will display the Site name. The bottom part of all process and trend screens will display the three most recent alarms from the Master alarm summary, above which is a button-bar for system-wide navigation. The largest, central part of the screen is dedicated to the actual graphic content of the screen, e.g. process equipment, trend chart, statistics information.

The location of the existing (upgraded) or new facility will determine integration of the new displays within the existing applications.

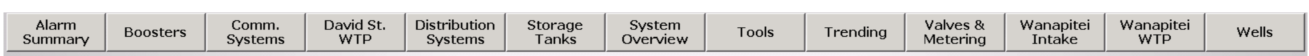
Sample SCADA screens are provided in Appendix G-2.

2.3.4.4 Navigation and Menus

Navigation is achieved through the use of navigation buttons.

Generally, two menu button-bars are expected on any screen.

Along the bottom part of the display is a system-wide menu bar that allows access to other facilities within the system, and access to the Master alarm summary.



In the upper part of the display is the facility-specific menu, allowing access to other screens related to the specific facility, therefore the number of buttons in this menu bar may vary from site to site. Below is one example of a facility-specific menu bar.

2.3.4.5 Graphics Colour Conventions

The SCADA system graphic objects, developed for both the water and wastewater facilities, will follow the standard colour code shown below:

- Red - Alarm/Equipment Off/Circuit Breaker Closed (Energized)/Valve Closed
- Green - Normal/Equipment Running/Circuit Breaker Open (De-Energized)/Valve Open
- Purple - Valve Opening/Closing
- Amber - Warning (High or Low analog alarm)
- Yellow - Alarming Disabled

The SCADA display standard background colour is Gray.

2.3.4.6 Standard Programming Routines

The City of Greater Sudbury baseline HMI application contains examples of graphics linked to the standard controller routines, which can be copied and pasted, and updated as applicable for development of new graphics.

2.3.4.7 Pop-up Displays

Pop-up displays are used throughout the standard SCADA application as means of operator interface when performing SCADA controls. Some examples of standard controls through use of pop-ups are:

- Various equipment control mode selections (Auto/Base/Time-of-Use);
- Equipment start/stop/forward/reverse/lockout/run speed control;
- Time of use scheduling;
- Pump lead-lag assignment and duty selection;
- Alarm control
- Tanks level control set point entry.

Sample standard control interfaces commonly used on the water and wastewater SCADA system pop-ups are included below.

<u>SCADA Control</u>

The SCADA control selection allows the operator to select between PLC control and SCADA manual control modes.

When in "PLC Control", the equipment operates automatically as programmed within the PLC. All software interlocks are active in this mode.

When in "SCADA Control", the operator is given the ability to start, stop and make set point adjustments manually through the SCADA system. In this mode, most software interlocks are bypassed.

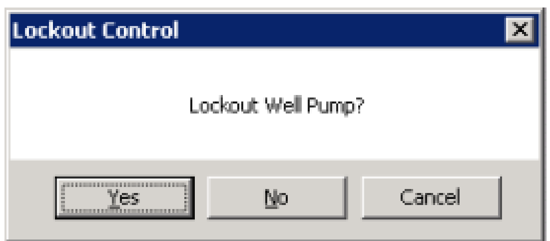
Once the piece of equipment has been placed in "SCADA Control" by the operator, the following image is displayed on the SCADA system:

When in "SCADA control", the Start and Stop buttons become active and available to the operator:

SCADA Lockout

SCADA Lockout Control is used to remove pieces of equipment from Automatic sequences.

When the operator clicks the “Lock Out” button, they are prompted to confirm their request through a dialog box, providing them with the option of cancelling the lockout request. If the operator selects “Yes”, then the lockout will proceed. If they click “NO, “Cancel”, or the X in the top right corner of the window, the lockout is not initiated.

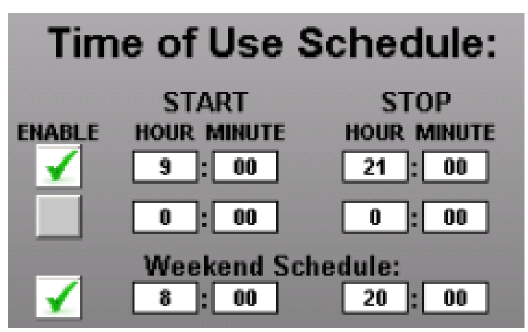


Note that a similar “Are You Sure?” type prompt is presented for every major control change (start, stop, control, mode change, etc.)

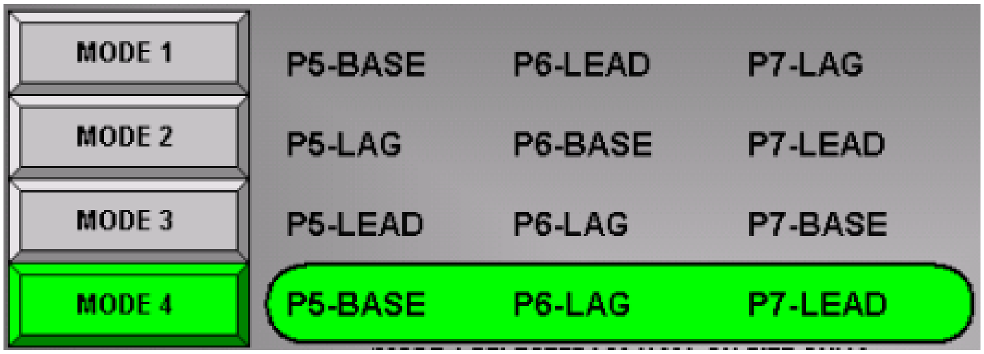
Once the piece of equipment has been locked-out by the operator, the following image is displayed on the SCADA system:

System Control

Various system controls are available through SCADA. Example SCADA interfaces for System Mode selection (Auto/Base/Time of Use), and Time of Use schedule are shown in the following figures.



Additional examples of system controls available through SCADA are shown in the following figures.



2.3.4.8 Standard Device Graphics and Pop-ups – General

The following are device graphics and related pop-up displays used in both water and wastewater sections of the SCADA application.

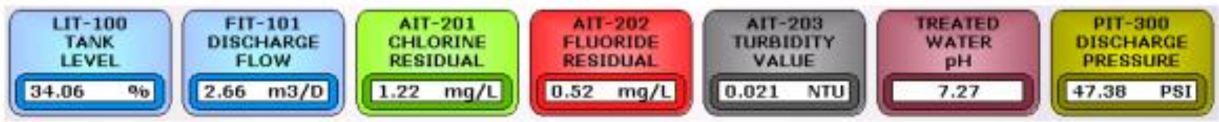
Analog Alarms

The Analog Alarm graphic is used to display the readings from an analog field instrument, and to provide notification if the analog reading is in alarm.

Depending on the quantity measured, the analog instruments are typically color-coded as follows, and as shown in the figure below:

- Blue – Level / Flow Rate
- Green – Chlorine Residual
- Red – Fluoride Residual
- Gray – Turbidity
- Purple – pH

- Gold - Pressure.

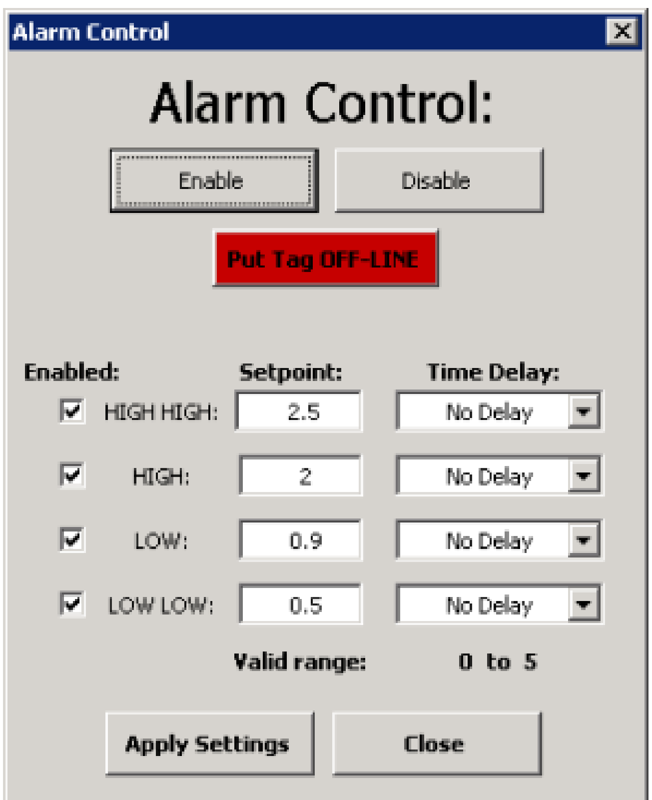


The Analog Alarm text is animated to flash from red to white until the alarm is acknowledged by an operator. The text remains red until the alarm clears, at which point it returns to its normal color of black.

When alarming is disabled, the white rectangle changes to yellow in color.

An analog device tag in the SCADA database can be placed online/offline, associated alarms can be enabled/disabled, and the analog alarm set points High-High, High, Low, and Low-Low can be modified from a dedicated popup, which is opened when an operator clicks on an Analog Alarm tile.

The Standard Analog Alarm pop-up is shown in the following image:



If the device is placed offline, the following would be displayed:

The center text flashes from red to yellow to draw the operator's attention.

Digital Alarms

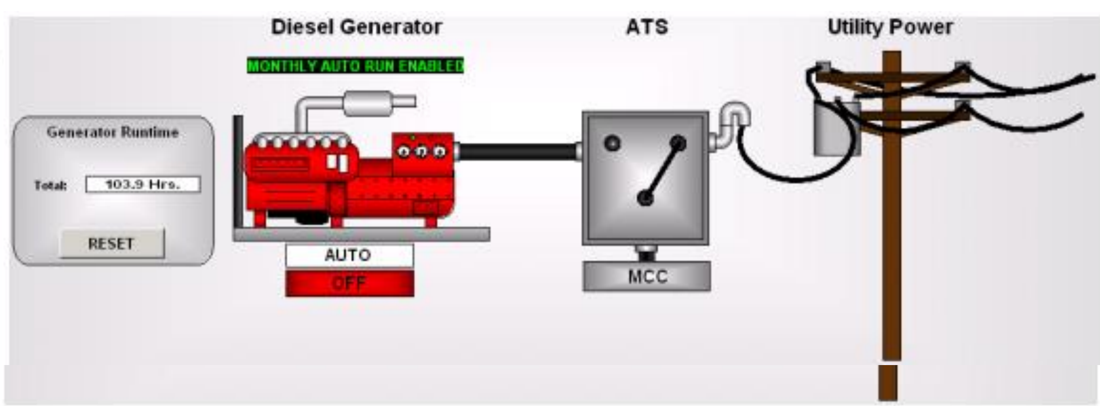
The Digital Alarm graphic is used to display the status of the digital alarm tags. When a new alarm is active on the SCADA system, the block's text will flash from red to white until the alarm is acknowledged by an operator. The text will remain red until the alarm clears, at which point it will return to its normal color of black. If the alarm is disabled, the alarm block is yellow. The figure above shows the Normal, Alarm (Active), and Disabled states of a sample digital alarm block.

When an operator clicks on a Digital Alarm tile, they are prompted with a popup, shown below.

From this popup, the operator is able to enable/disable alarming, place the database tag online/offline, or modify the delay time before the alarm will become active on the SCADA system.

<u>Emergency Power</u>

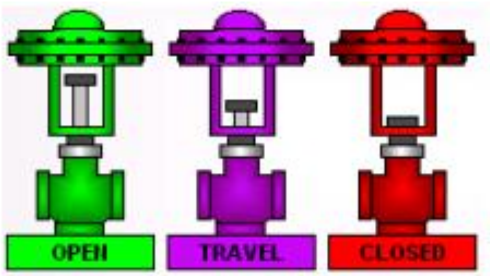
The following two figures show typical representation of the emergency power status used by the SCADA system, showing animations for diesel generator standby operation (stopped, with automatic transfer switch on utility power), and for diesel generator on-line (running, with automatic transfer switch on emergency power) respectively.

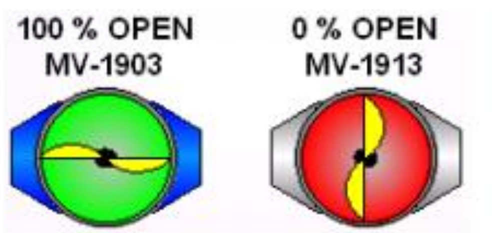


The next figure shows a pop-up screen which provides the interface for typical SCADA control of the emergency diesel generators (where available):

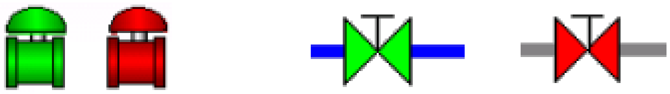
Valves

The following are typical valve graphics and standard color and text animations for modulating valves.





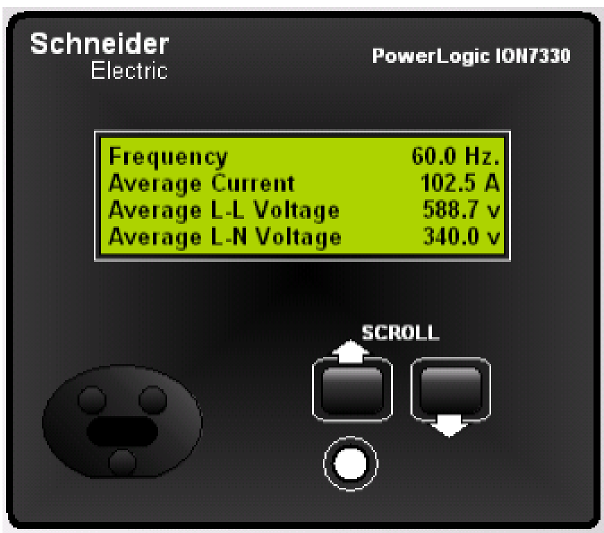
The following are typical valve graphics and standard color and text animations for open/close valves.



The following popup screens display typical SCADA interface for valves (where remote controls are implemented):

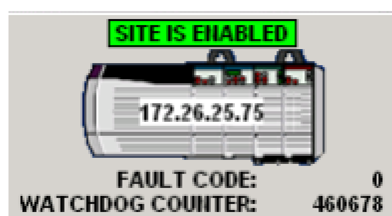
Power Monitor

The following image shows the interface used for display or power monitoring readings in the SCADA system.



Controller Info

The following image shows the interface used for PAC status monitoring in the SCADA system. This graphic displays the PAC's IP address, watchdog counter, and fault code information.

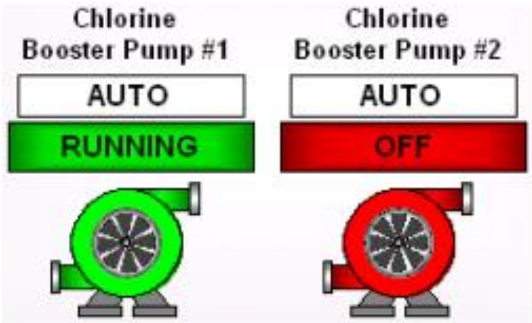


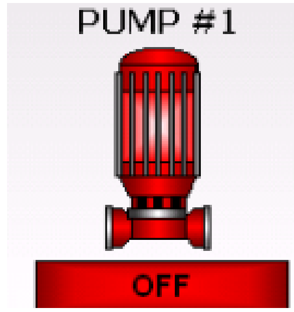
2.3.4.9 Standard Device Graphics and Pop-ups – Water

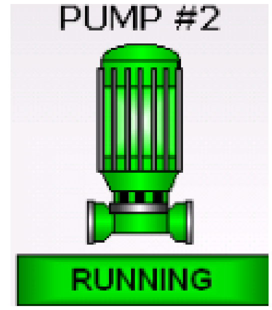
The following device graphics and related pop-up displays are used in water section of the SCADA application.

Booster Pumps

The following are typical pump graphics and standard animations used for booster pumps:



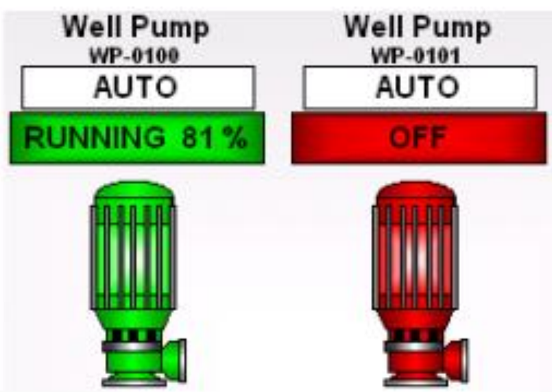


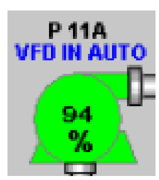


The following is an example pop-up screen providing typical SCADA control functionality for booster pumps (where available):

Water Pumps

The following are typical pump graphics and standard animations used for water pumps:



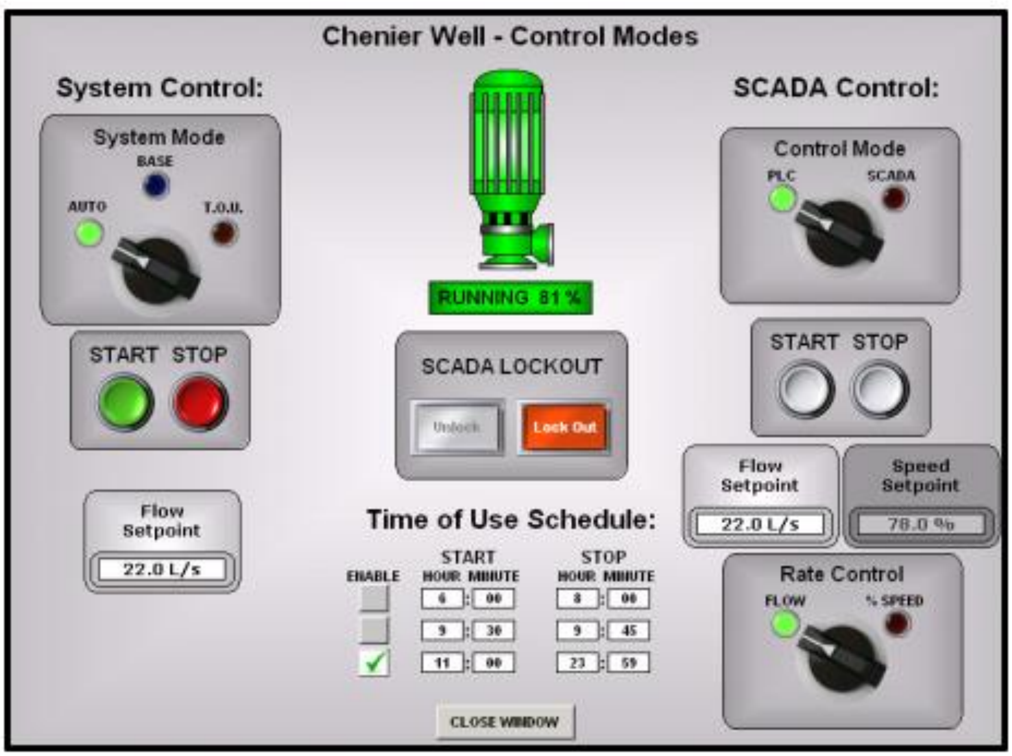


Where the pumps are VFD-controlled, as in the given examples, VFD speed feedback is displayed in addition to the running indication.

For constant speed pumps, the “On”/”Off” status would be similarly displayed through colour and text visibility animation, however, there would be no speed reference included; also, there would be no display of VFD mode.

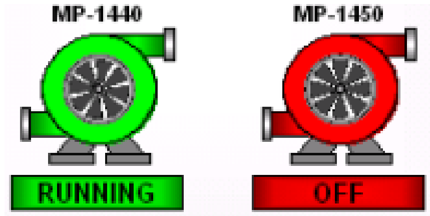
This approach, generally applies to any other equipment that is running with/without speed feedback.

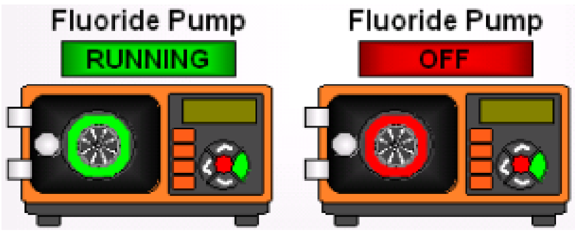
The following example SCADA pop-up screens are typical for water pumps:

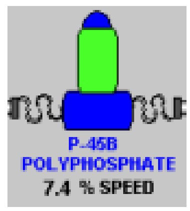


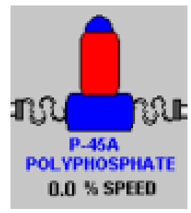
Chemical Pumps

The following are typical pump graphics and standard animations used for chemical pumps:

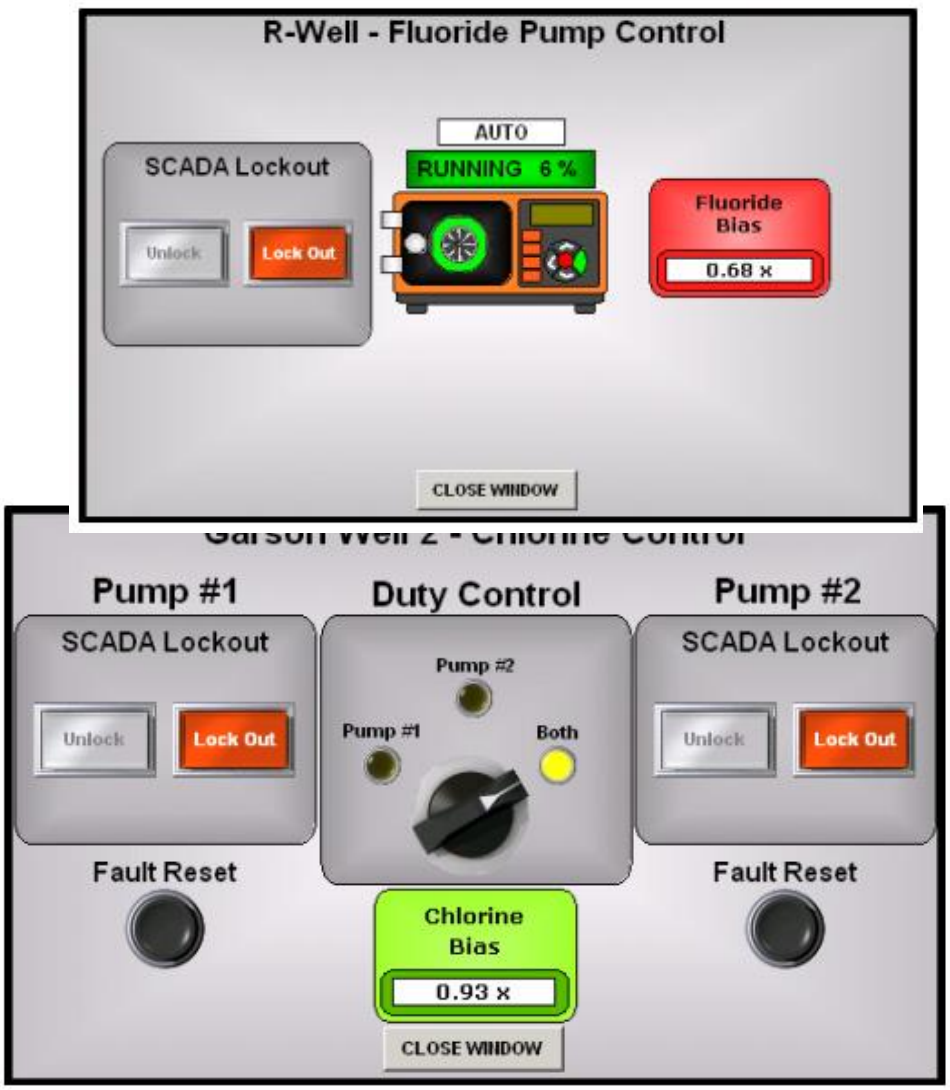






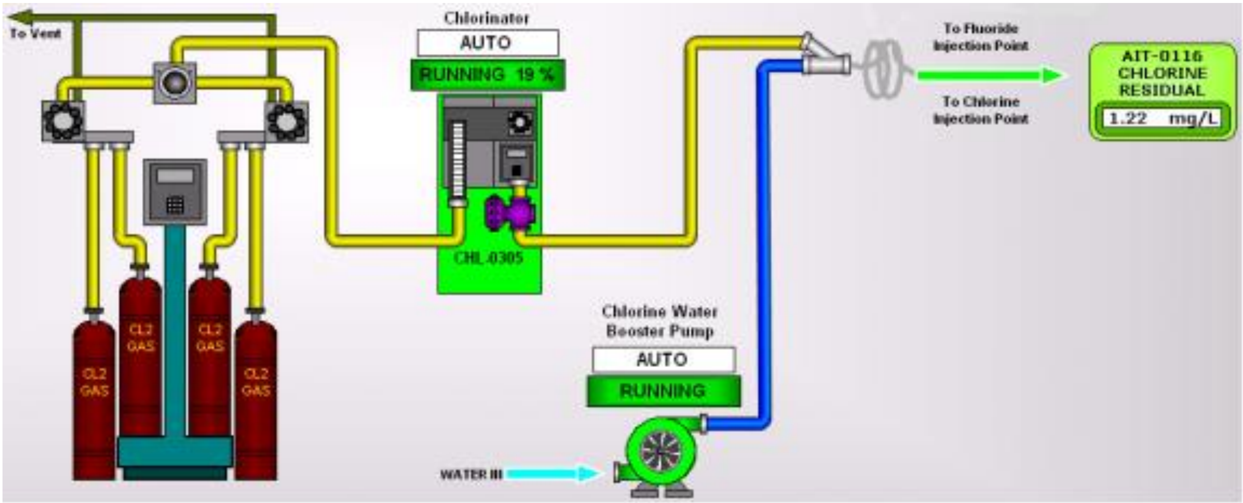


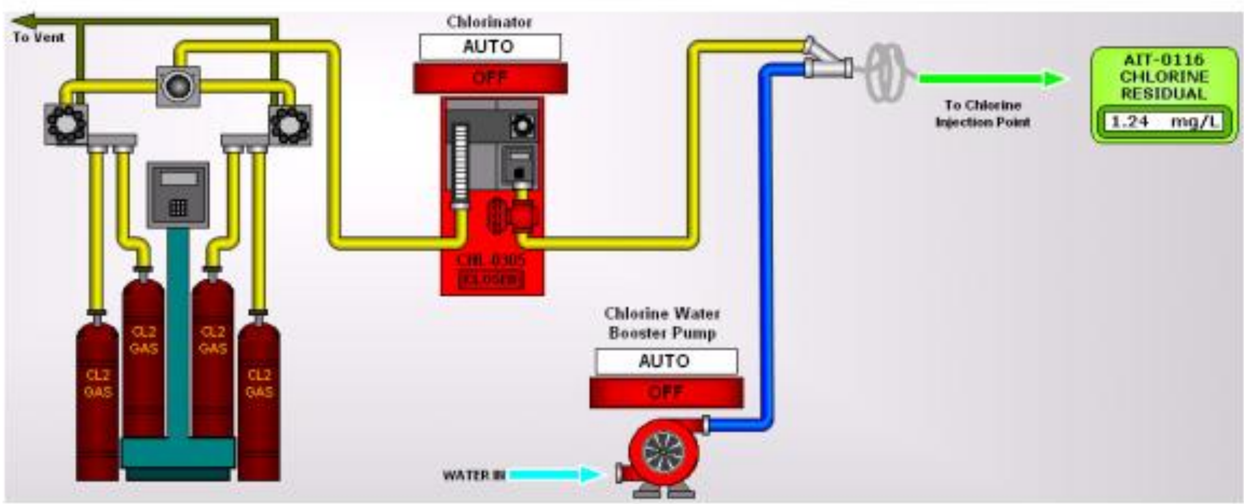
The following popup screens display typical SCADA control for chemical pumps (where available):



Chlorination Systems

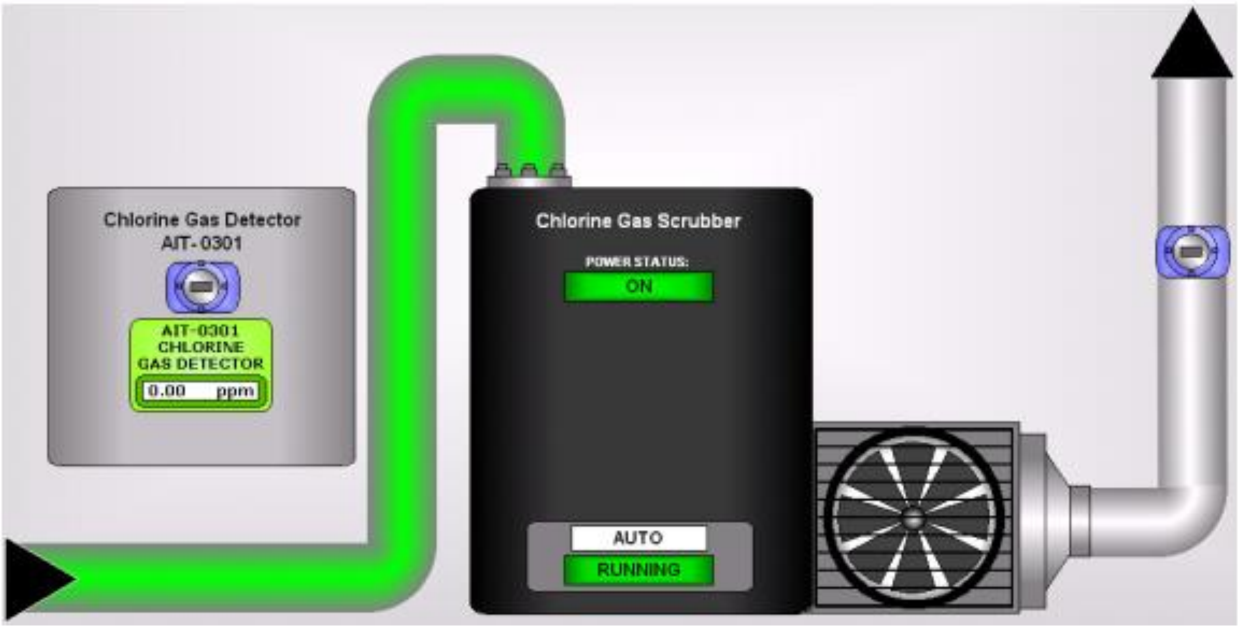
The following are examples of the standard graphics and animations used for displaying the status of the equipment that is part of chlorination systems.

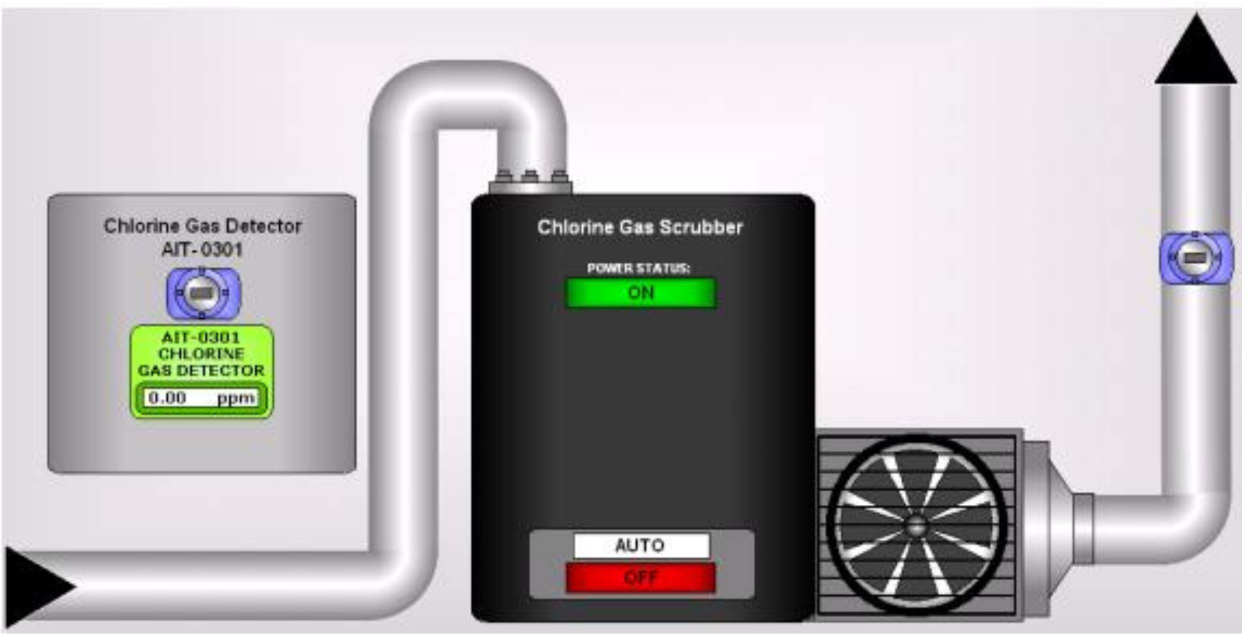




Hazardous Gas Scrubber

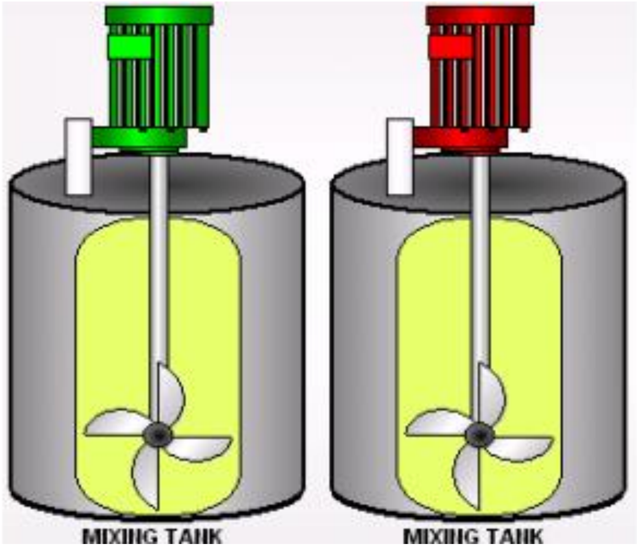
The following are the standard graphics and animations used for displaying the status of the chlorine gas scrubber.

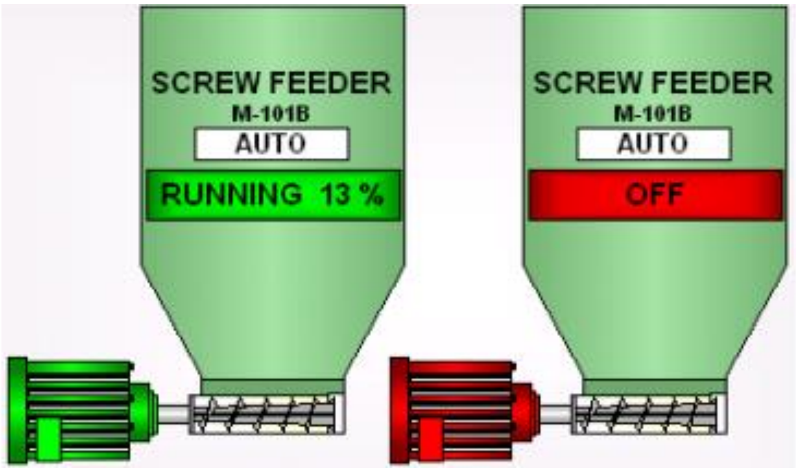




Mixers and Feeders

The following are the standard graphics and animations used for displaying the status of the chemical mixers and feeders.

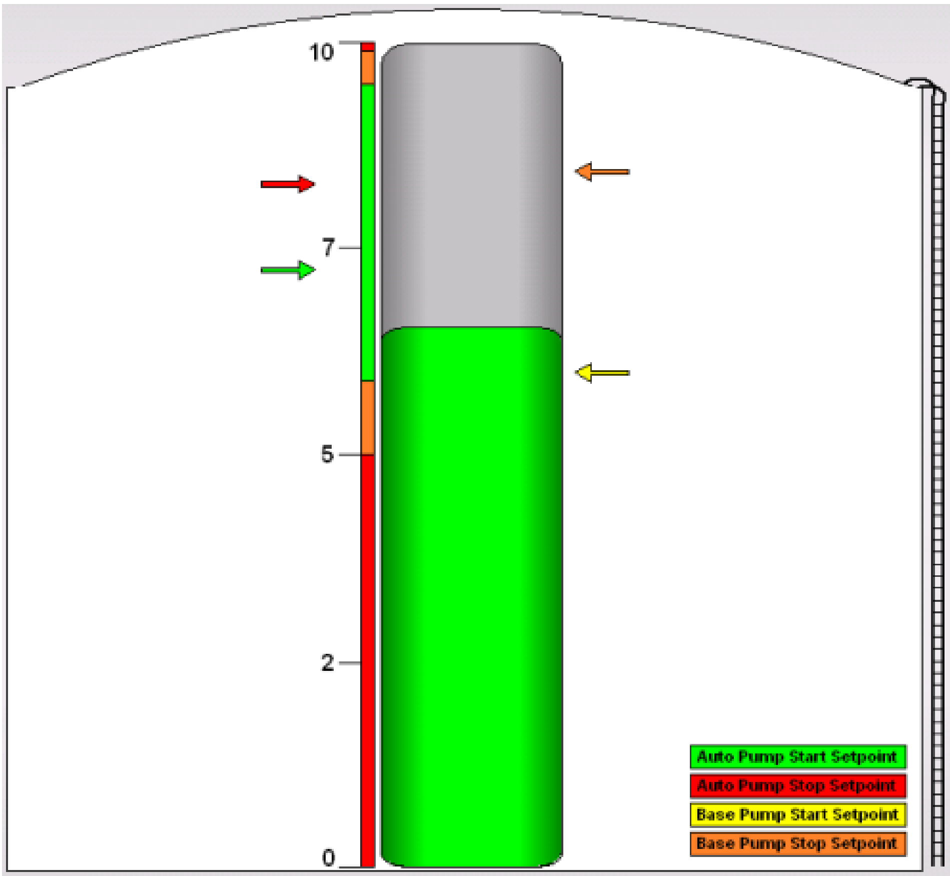




Storage Tank

The following is the standard graphic representation and visual animations used for storage tanks monitoring in SCADA.

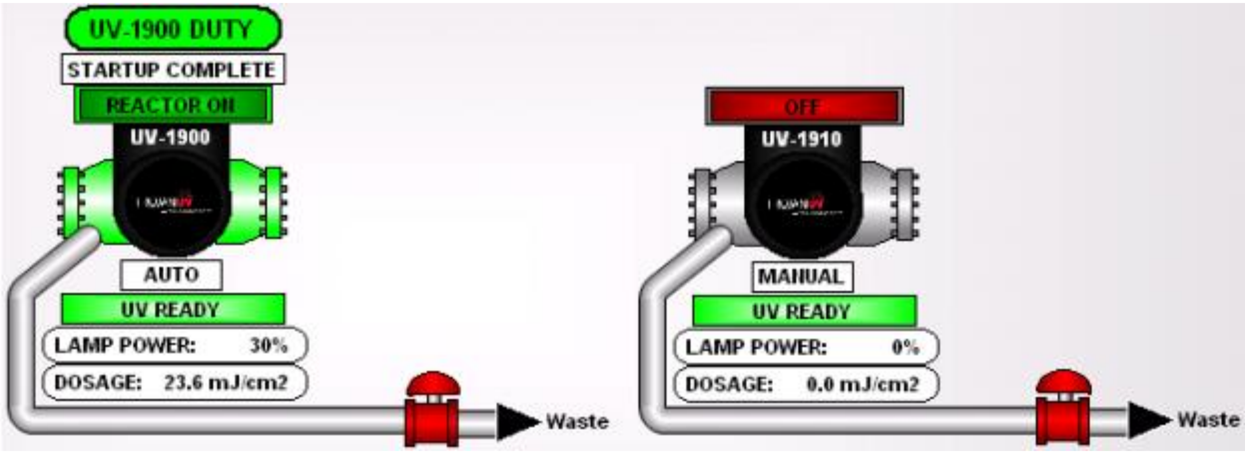
The storage tank level is represented by a bar-graph, and the base/auto pump start/stop set points are indicated by arrows.

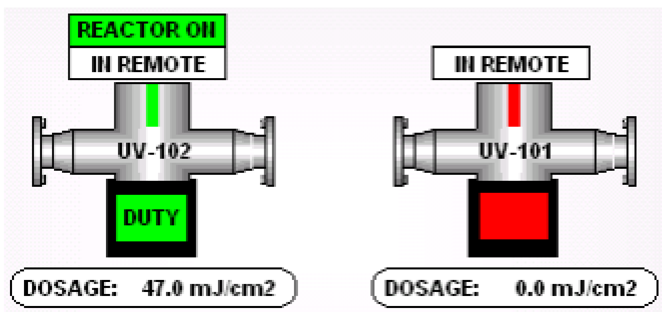


Standard control pop-up displays associated with storage tanks are shown in the images below. Pump start/stop set points are entered from this popup.

UV Disinfection Systems

The following is the standard graphic interface providing SCADA monitoring of the UV disinfection systems status.





In the event that a UV unit is bypassed, the following is displayed:

2.3.4.10 Standard Device Graphics and Pop-ups – Wastewater

The following are device graphics and related pop-up displays used in wastewater section of the SCADA application.

Wet Wells

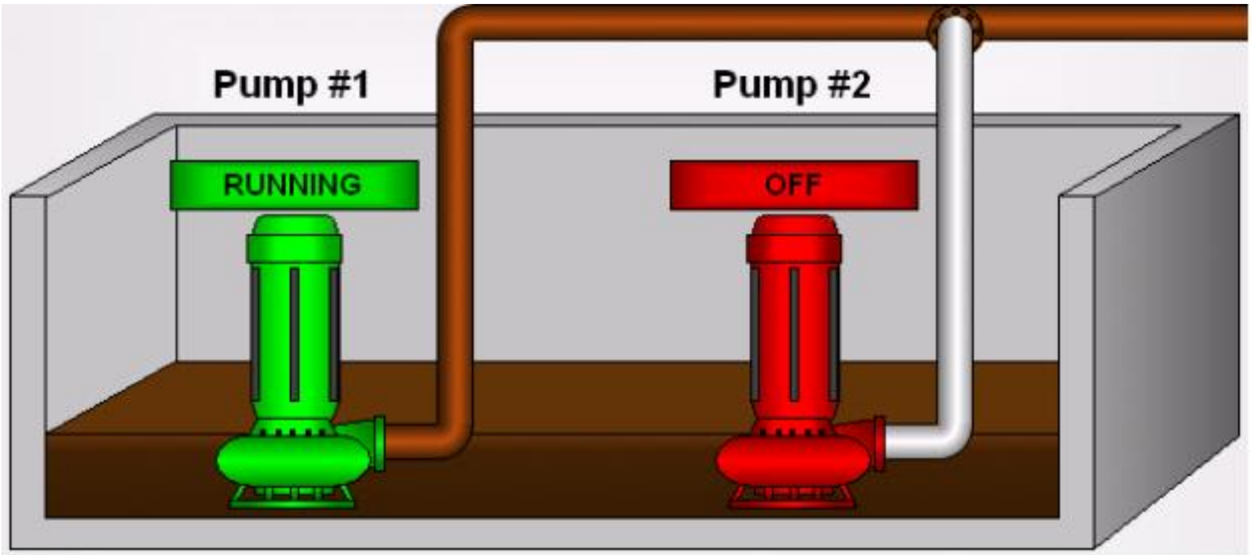
The following is the image of the standard graphics for wet well with the corresponding level indication.

Sluice Gates

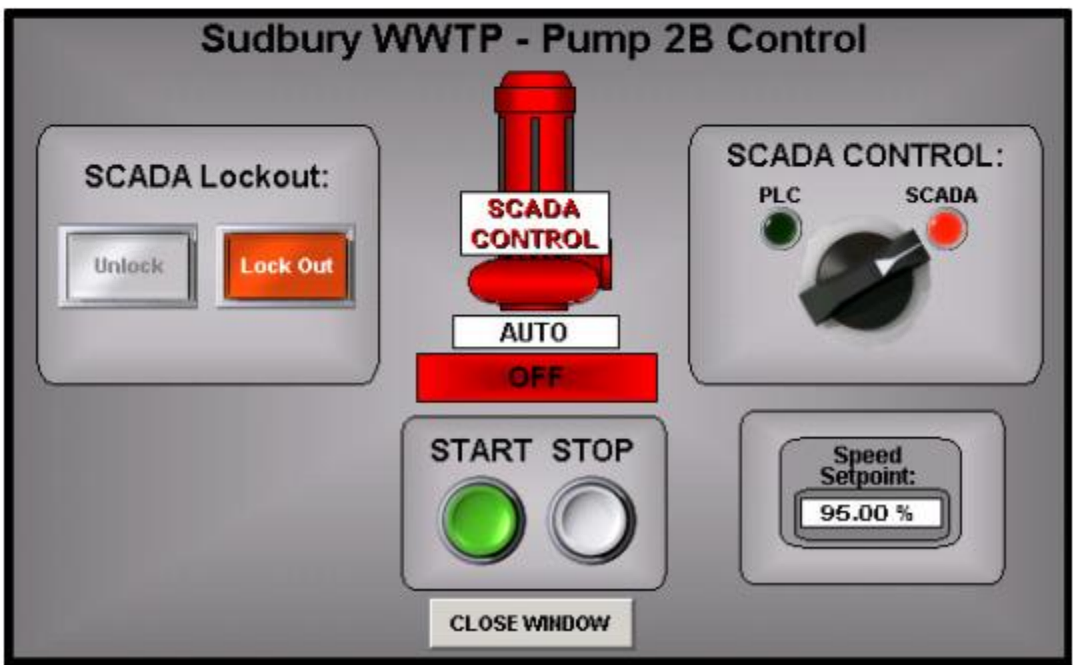
Standard graphic interface for sluice gate provides both monitoring and control functions, as shown in the following image.

Lift Station Pumps, Sump Pumps, Raw Pumps

Lift Station Pumps, Sump Pumps and Raw Pumps all use the following graphical interface for status monitoring in the SCADA system.

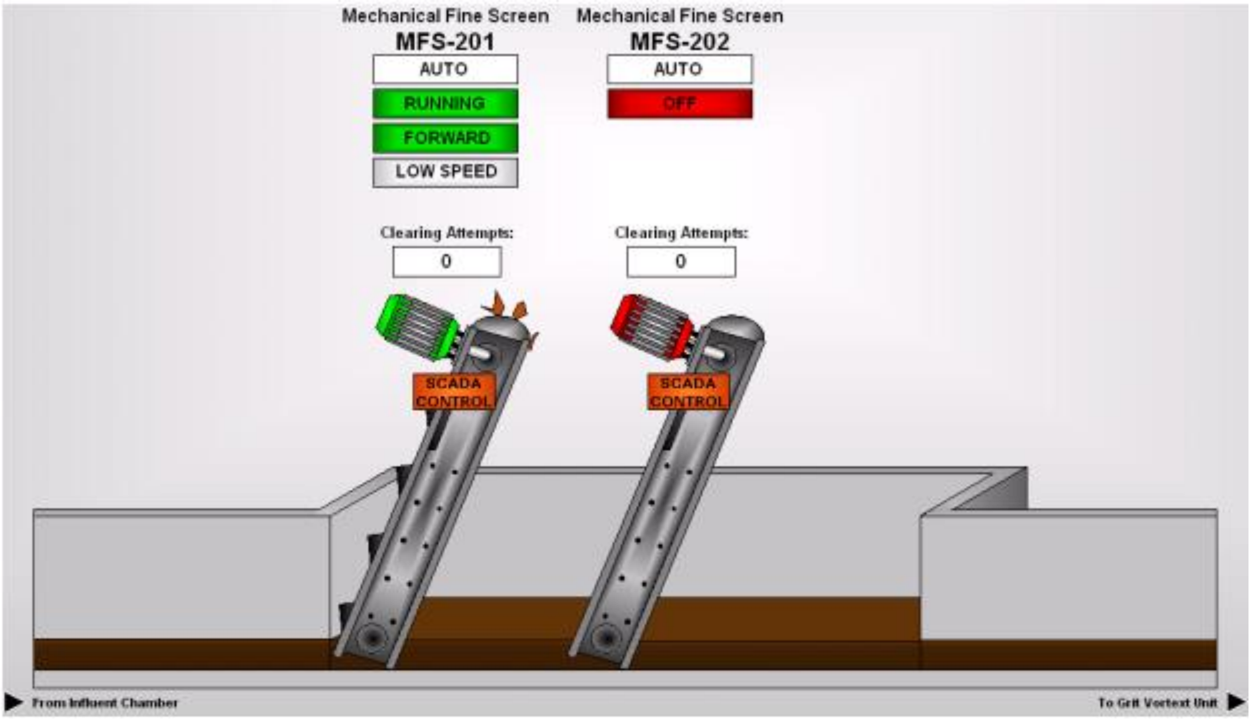


There is a control popup associated with the pumps, wherever remote controls are implemented. The popup opens by clicking on the pump graphic on the main display.

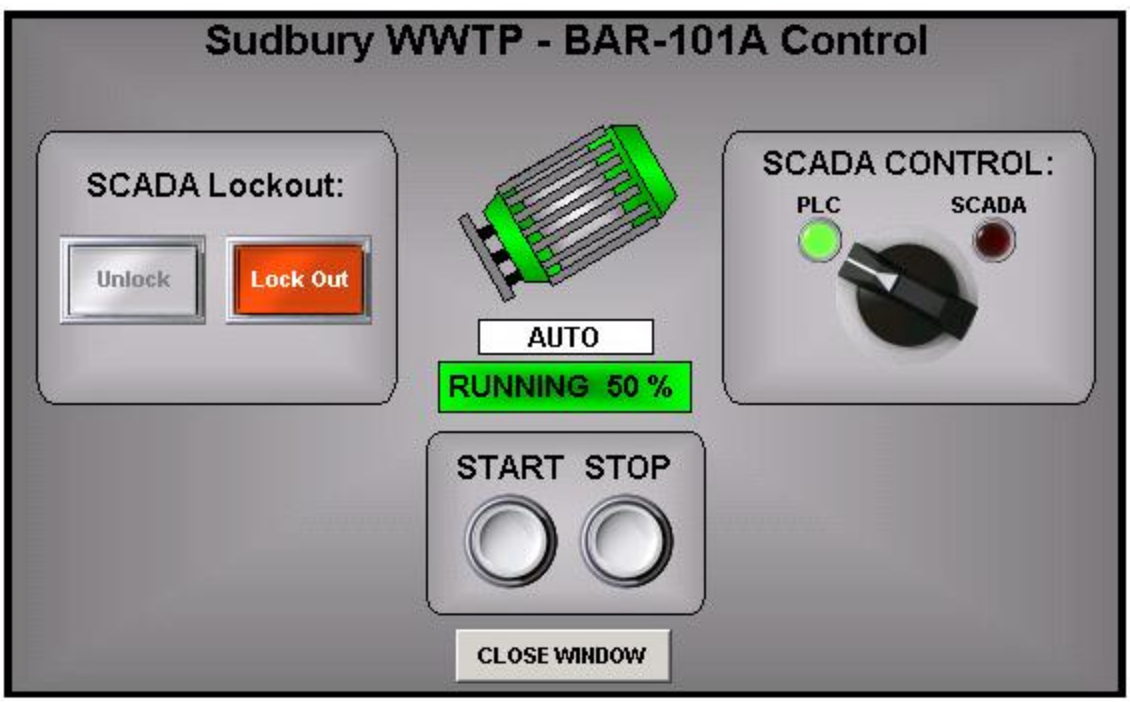


Mechanical Bar Screens

The following image shows the mechanical bar screen (coarse & fine) status display used in the SCADA system.

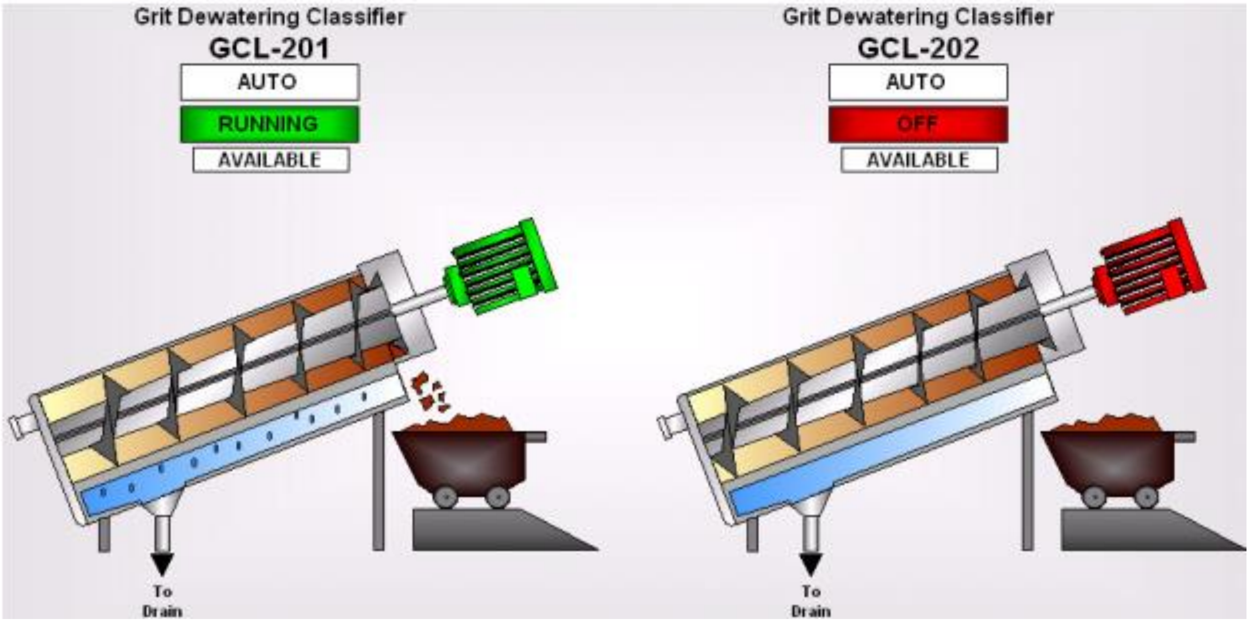


By clicking on any of the equipment, the operator will be presented with a SCADA control pop-up:



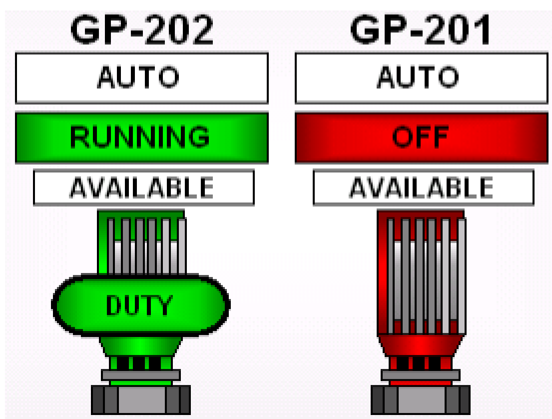
Grit Classifiers

The following image shows the grit classifier status displays used by the SCADA system.



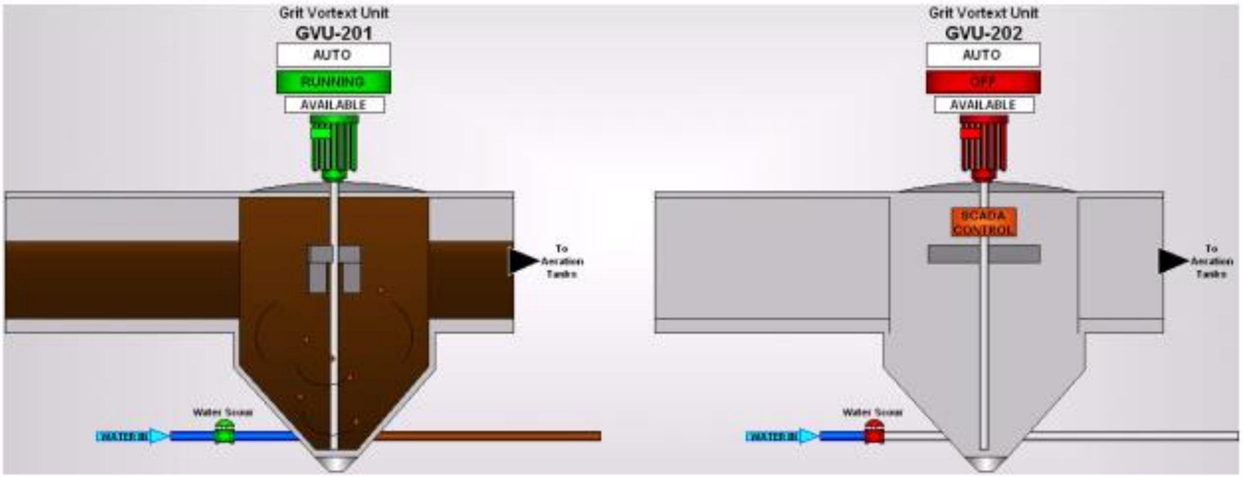
Grit Pumps

The following image shows the grit pumps status displays used by the SCADA system.



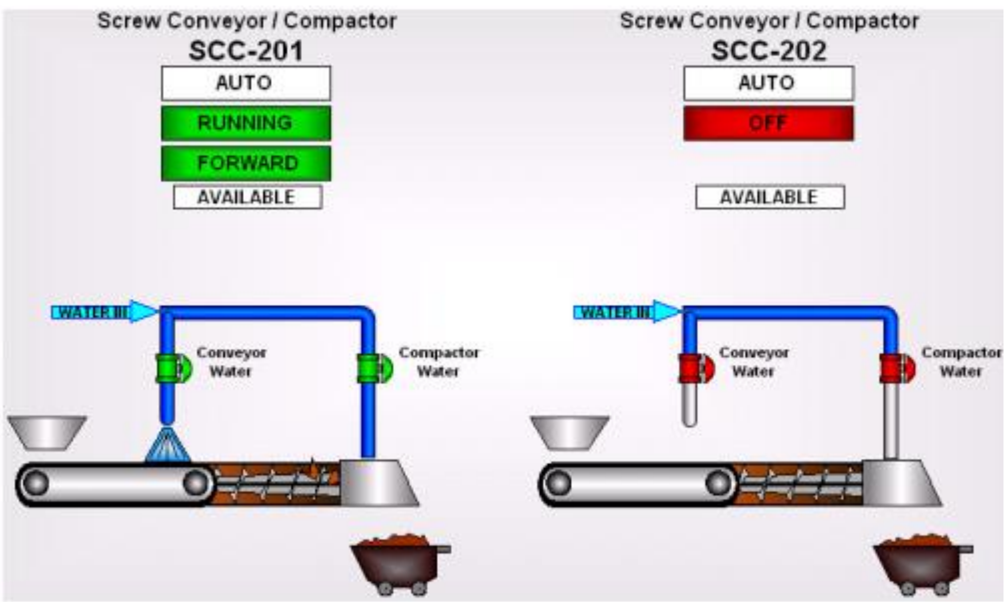
Grit Vortex

The following image shows the grit vortex unit status displays used by the SCADA system.



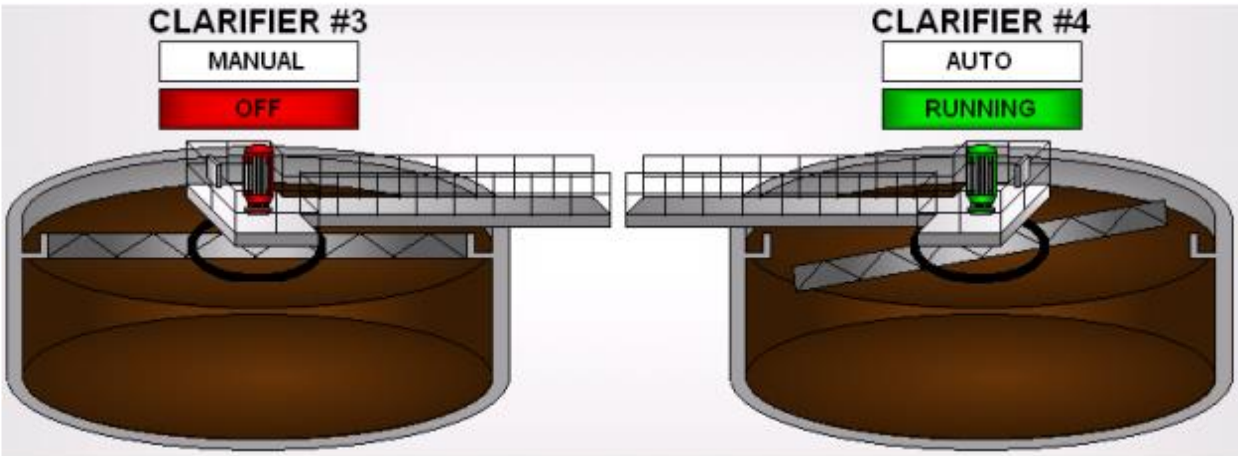
Screw Compactors

The following image shows the screw conveyor and compactor status displays used by the SCADA system.



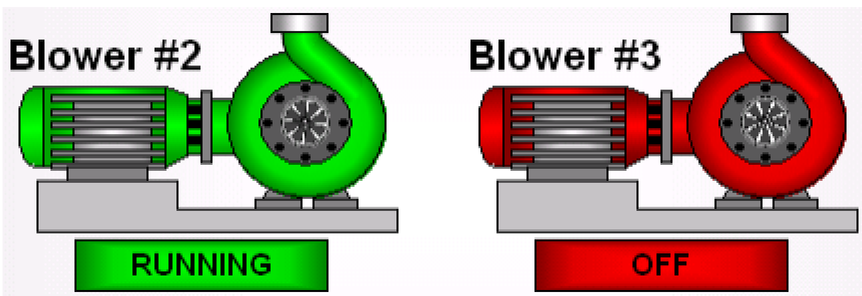
Clarifiers

The following is an image of the standard SCADA graphic and animations for the clarifiers.



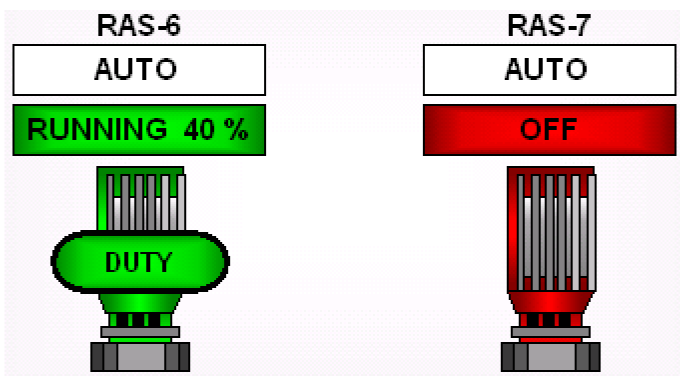
Air Blowers

The following images show the air blower status display used by the SCADA system.



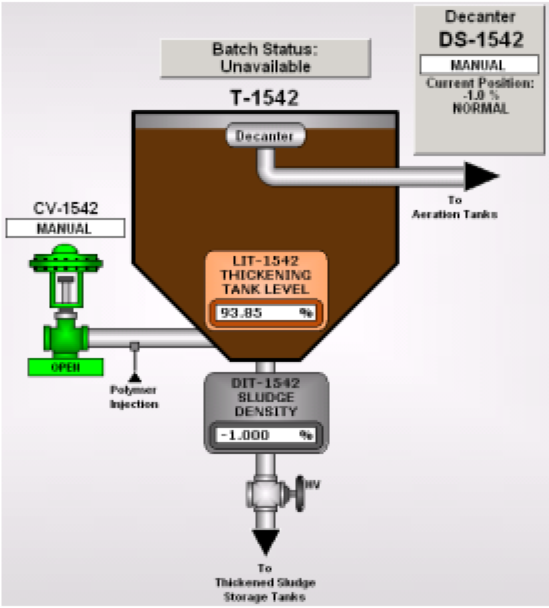
RAS/WAS Pumps

The following images show the standard graphic and animations used for RAS and WAS pumps status display in SCADA.



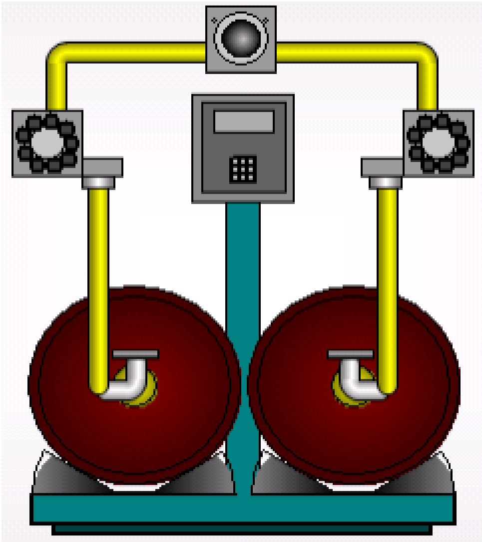
Sludge Thickening Tanks

The following image shows the sludge thickening tank system status display used by the SCADA system.



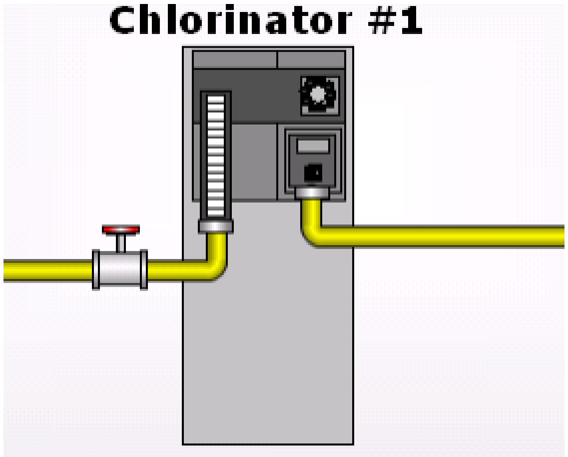
Chlorine Cylinders and Scale

The following image shows the chlorine cylinder & scale status display used by the SCADA system.



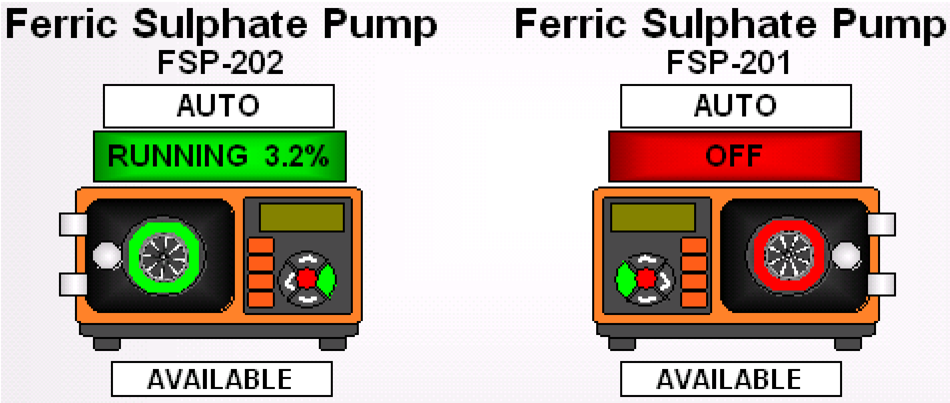
Chlorinators

The following image shows the chlorinator status display used by the SCADA system.



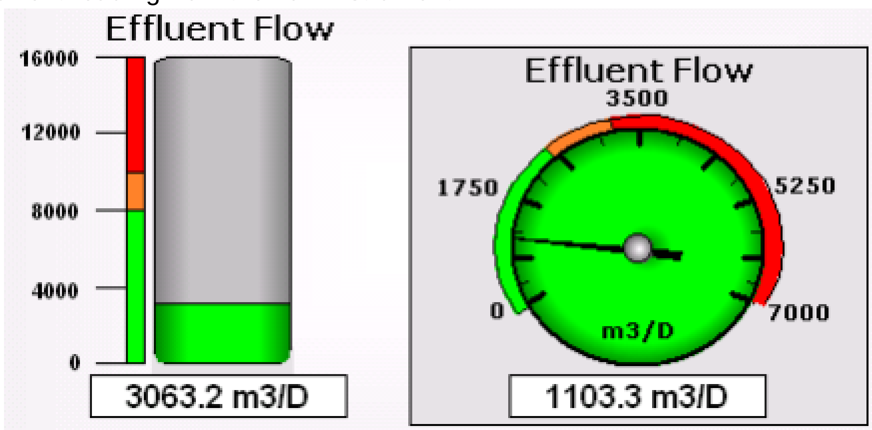
Chemical Pumps

The following images show the standard graphic and animations used for chemical pumps status display in SCADA.



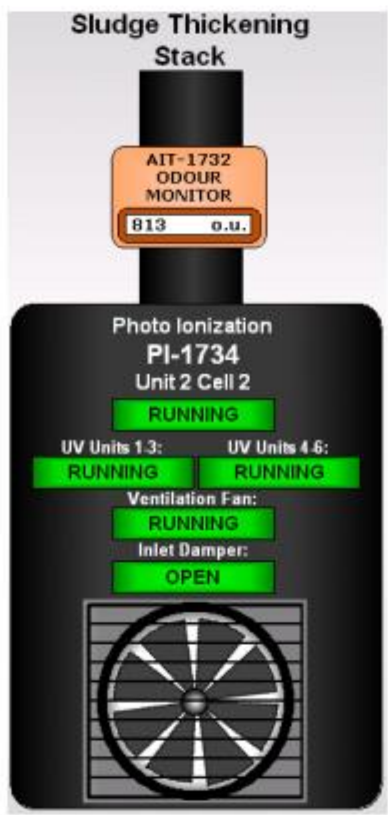
Raw / Influent / Bypass Flow Meter

The following images show the flow meter representation displayed on the SCADA system. The vertical graph on the left-hand side of the flow reading bar-graph / outer circular graph on the analog readout corresponds to the operator-entered alarm set points. The bar-graph / analog readout are animated based on the current reading from the flow instrument.



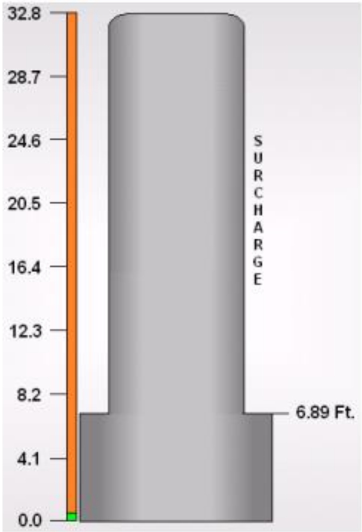
Odour Monitoring System

The following image shows status display of odour control system as used by SCADA.



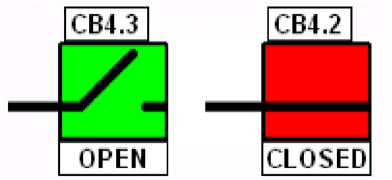
Rock Tunnel Level

The following image shows the rock tunnel level display used by the SCADA system.



Circuit Breakers

The following image shows the standard graphic and animations for circuit breaker status display in the SCADA system.



2.3.4.11 Alarms

Alarm tags represent events that take place in the field and require specific attention from the operator. Event tags are all discrete tags that are not classified as alarms. This includes start / stop commands, running status bits, and duty selection and reset bits.

The Alarm Summary Object (OCX) application allows interaction with the system by manipulating the Alarm Summary Object embedded in a picture.

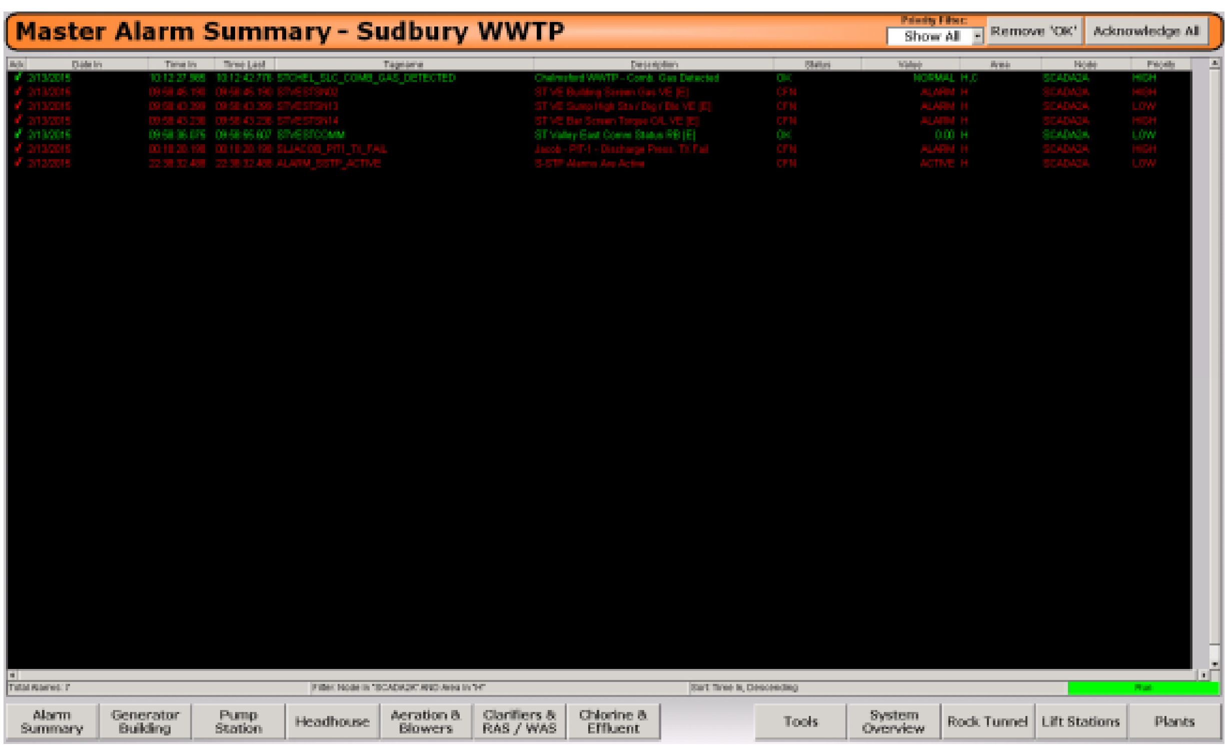
Alarms are displayed in the alarm summary with assigned priorities. From the alarm summary, the operator has the ability to acknowledge any alarms that register on the SCADA system that their security clearance grants access to.

The Alarm Summary screen used in the Water section of the SCADA system is, generally, dedicated (through adequate alarm filtering) to the Wanapitei WTP and the David Street facility, but also provides the ability to monitor and acknowledge all water and wastewater alarms from the same screen (by removing the filtering). Any new alarms will flash in the summary and sound the overhead alarm at the treatment plant.

The following image shows the alarm summary that is used for the water section of the SCADA system:

Alarm priority grouping is not currently enabled for the water side of the SCADA system.

The Alarm Summary screen used in the wastewater section of the SCADA system is, generally, dedicated to alarms for the Sudbury WWTP. There is, however, the ability to monitor and acknowledge the alarms from the Wanapitei WTP as well from this screen. Any new, unacknowledged alarms will flash



in the alarm summary banner, and will sound the overhead alarm at the treatment plant. The following image shows the alarm summary that is used for the wastewater section of the SCADA system:

For the wastewater section of the SCADA system, the operator also has the ability to filter the alarms based on priority.

SCADA Alarm Priority Grouping for Wastewater

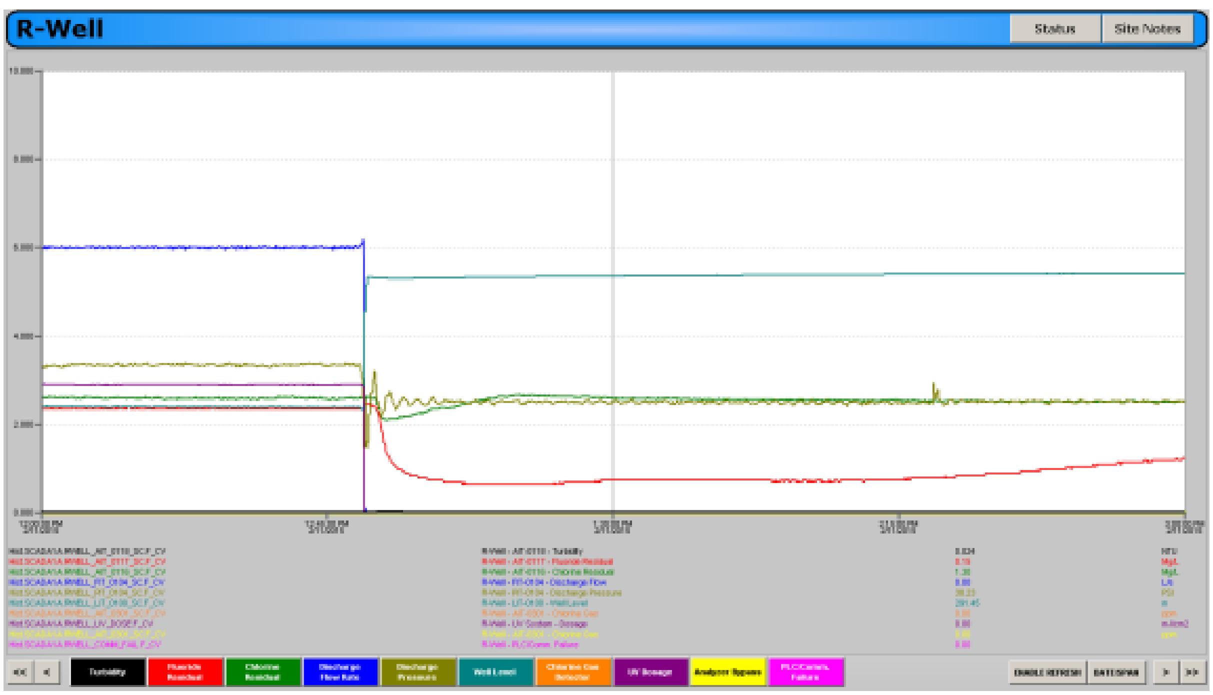
- Critical Priority Alarms
  - High Well (Specific Sites Only)
  - Chlorine Leak
  - Fire Alarm / Smoke Detector / Heat Detector
- High-High Priority Alarms
  - High Well (Non-Critical Sites)
  - Low Well Lockout
  - Pump Fault
  - Valve Fault
  - Blower Fault
  - Equipment Failure
  - PLC Fault
  - AC Power Failure
  - Control Power Failure
  - Pump/Mixer/Blower/Screen Fail To Start/Stop
  - Valve Fail To Open/Close
  - High Sump Level
  - Low Sump Level
  - E-Stop
- High Priority Alarms
  - Communication Failure
  - Analyzer Transmitter Failure
  - Pump/Mixer/Blower/Screen/Clarifier Overload
  - Pump Runtime Alarms

  - Gas Detection
- Medium Priority Alarms
  - General Alarm
  - Diesel Running
- Low Priority Alarms
  - Instrument Analyzer Exceeds Set point
  - Building/Panel Low Temperature
  - Misc. Alarms

2.3.4.12 Historical Collection and Trending

Historical Collect is a system application. Once started, it retrieves data and stores it in the Historical Data directory defined in the SCU. The system is configured to automatically start Historical Collect when iFIX starts up. The historical data is stored as .H24 files.

The following figure shows a typical trend screen showing a trend chart based on historical data. This standard trend display is applicable to both water and wastewater.



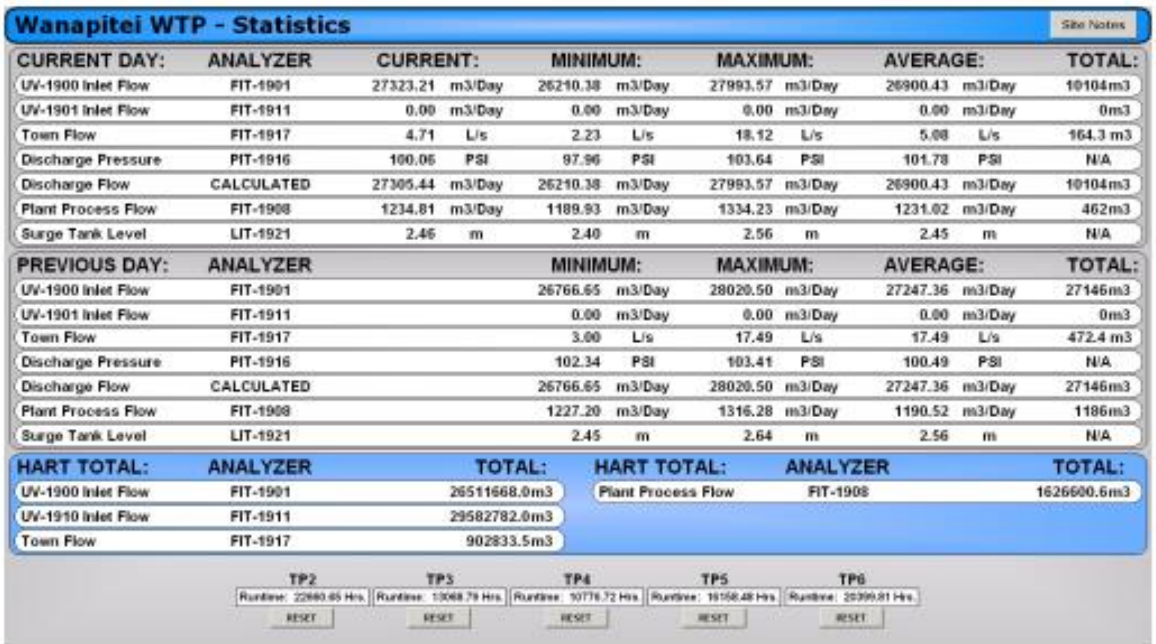
From this screen, the operator can enable/disable specific chart pens, select a date/time to load, and zoom in/out as required. They also have the ability to enable the automatic refresh function which will update chart data every 10 seconds on a continual basis.

The trend screens are typically color-coded as follows (where possible):

- Blue - Flow Rate
- Gold - Pressure
- Green - Chlorine Residual
- Red - Fluoride Residual
- Black - Turbidity
- Yellow - Analyzer Bypass
- Pink - PLC/Communication Failure
- Purple - pH

2.3.4.13 Statistics

Statistics screens display the statistics from essential instrumentation readings, such as maximum, minimum, average and total (flows only), for the current day and previous day. The following is a sample statistics screen typical for water and wastewater.



Wanapitei WTP - Statistics Site Notes

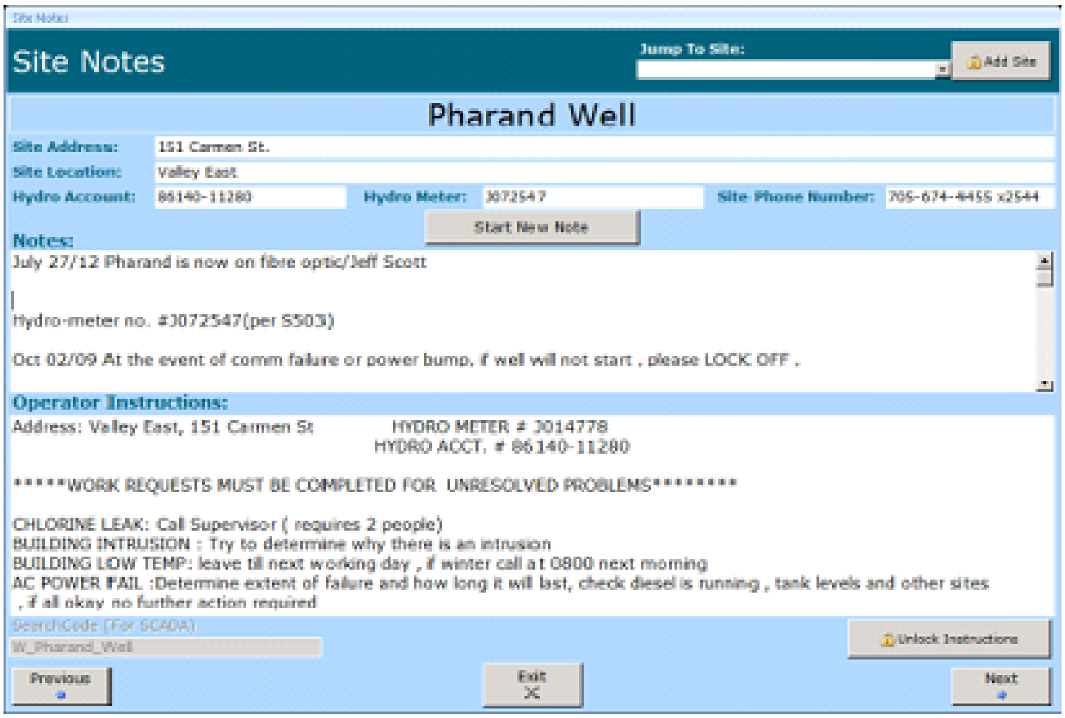
CURRENT DAY:	ANALYZER	CURRENT:		MINIMUM:		MAXIMUM:		AVERAGE:		TOTAL:
UV-1900 Inlet Flow	FIT-1901	27323.21	m3/Day	26210.38	m3/Day	27993.57	m3/Day	26900.43	m3/Day	10104m3
UV-1901 Inlet Flow	FIT-1911	0.00	m3/Day	0.00	m3/Day	0.00	m3/Day	0.00	m3/Day	0m3
Town Flow	FIT-1917	4.71	L/s	2.23	L/s	18.12	L/s	5.08	L/s	164.3 m3
Discharge Pressure	PIT-1916	100.06	PSI	97.96	PSI	103.64	PSI	101.78	PSI	N/A
Discharge Flow	CALCULATED	27305.44	m3/Day	26210.38	m3/Day	27993.57	m3/Day	26900.43	m3/Day	10104m3
Plant Process Flow	FIT-1908	1234.81	m3/Day	1189.93	m3/Day	1334.23	m3/Day	1231.02	m3/Day	462m3
Surge Tank Level	LIT-1921	2.46	m	2.40	m	2.56	m	2.45	m	N/A

PREVIOUS DAY:	ANALYZER	MINIMUM:		MAXIMUM:		AVERAGE:		TOTAL:
UV-1900 Inlet Flow	FIT-1901	26766.65	m3/Day	28020.50	m3/Day	27247.36	m3/Day	27146m3
UV-1901 Inlet Flow	FIT-1911	0.00	m3/Day	0.00	m3/Day	0.00	m3/Day	0m3
Town Flow	FIT-1917	3.00	L/s	17.49	L/s	17.49	L/s	472.4 m3
Discharge Pressure	PIT-1916	102.34	PSI	103.41	PSI	100.49	PSI	N/A
Discharge Flow	CALCULATED	26766.65	m3/Day	28020.50	m3/Day	27247.36	m3/Day	27146m3
Plant Process Flow	FIT-1908	1227.20	m3/Day	1316.28	m3/Day	1190.52	m3/Day	1186m3
Surge Tank Level	LIT-1921	2.45	m	2.64	m	2.56	m	N/A

HART TOTAL:	ANALYZER	TOTAL:	HART TOTAL:	ANALYZER	TOTAL:
UV-1900 Inlet Flow	FIT-1901	26511668.0m3	Plant Process Flow	FIT-1908	1626600.6m3
UV-1910 Inlet Flow	FIT-1911	29582782.0m3			
Town Flow	FIT-1917	902833.5m3			

2.3.4.14 Site Notes

The City of Greater Sudbury iFix application has a Site Notes feature which allows operators a shortcut to an Access database, where they can edit information or leave instruction notes about important issues on equipment and operations related to both water and wastewater sites. The following is a sample site notes interface display:



2.3.4.15 Project Related Application Updates

Project specific updates to configuration of existing SCADA servers generally include the following:

- Communication (I/O) Server Configuration (updated channel/device/tag configuration);
- iFix Database import;
- Update of application files on a backup (development) server (e.g. overview screens and navigation buttons update);
- Installation of new and updated application files on a backup (development) server,
  - Pictures (GRF) and (if any) tag group (TGD) files are to be saved in the C:\iFix_Public\Pic folder,
- Deleting of the old files as applicable;
- Verification of the new and updated files from the workstations (view nodes) based on mapping to the corresponding folders on the servers (e.g. PIC, HTR), verification of navigation.

When making changes to the SCADA system, the System Integrator is required to update the affected servers and verify all workstations.

3 Data Management

The City of Greater Sudbury has one dedicated Historian server, SCADAHS2 (iFIX Historian), which is located on the 2nd Floor at Tom Davies Square (TDS). This server collects and stores all historical SCADA data (not in production yet). Each SCADA server collects historical data and saves to .H24 files locally.

When making changes to the SCADA system, the programmer will not need to update the SCADA Historian but must notify the City of Greater Sudbury SCADA Group when the work they have completed would dictate changes to the tag database in the Historian. This includes the addition, modification, or deletion of any tags in the iFIX database.

3.1 iHistorian

The iHistorian is a Process Historian (Database) that collects information from each of the iFIX I/O Servers to build a process data repository. iHistorian collector exists on each SCADA server, and it forwards the data to the iHistorian server. The iHistorian database collects the process data at a high frequency (1 second) and serves as the plant (central site) level repository for Historical Data. While there will be many tags in the SCADA database, not all of them will be required for the iHistorian Server (rather, an average of 20 to 30% of SCADA tags will be collected). (Not in production yet)

The Consultant will define, in the PCN, all of the SCADA points that are required for historical collection.

As a guideline, all process signals should be included, such as:

- Flow
- Pressure
- Level, Analytical measurements (Chlorine Residual, Turbidity, pH, etc.)
- Temperature
- Valve, Damper, Gate Positions
- Drive Speeds
- Real Power
- Real Energy
- Equipment status
- Virtual points such as summations and calculations (e.g. summations of flows or totalized flows/volumes). Summation points should be collected from the PLC, not calculated in the HMI or iHistorian.

Alarm signals such as level, flow, pressure, temperature, gas alarm, etc. and equipment commands/changes in status do not need to be included in iHistorian, as they will be present in the alarm and event logs, with the exact time of state change recorded.

3.1.1 iHistorian Tag Limits

The iHistorian System is licensed on a tag count basis as the number of tags in the iHistorian license cost increases on a plateau basis. If the iHistorian tag count moves above the plateau into an unlimited tag license, there are no restrictions to adding points on a license cost basis. There is a vendor recommended limit to the performance of the iHistorian Database of 100,000 points on a 1 second poll time.

3.2 Reporting Requirements

A reporting system provides reports based on the historical data that is collected and calculated by one or more software systems. Different types of facility reports are required to be identified and categorized. A report template is developed for each type of report, from which subsequent reports are created.

Some facility categories for reporting are:

- Water Storage Facility
- Sewage Collection Facility
- Water Booster Facility
- Well Facility

3.2.1 Report Type

The report type needs to be defined. Typical report types are:

- regulatory compliance, (stating the regulation);
- real-time, current and previous day process operations (like SCADA trending);
- historical process operations for a week, month, year;

Also required to be defined with the report type is the report period such as Monthly, Annual, etc.

3.2.2 Report Items

Reports Items are rows of information that are to be presented on a report. Each item to be listed on the report must be defined including the number of significant digits to be shown for the report value. The frequency (timestamp) of each report item also needs to be defined in addition to requirements for rollup summary data typically provided at the bottom or in the flagged annotations area of the report.

Each Report Item is to be named by a parameter that represents a measurement. The units for the parameter must be defined as well as the text for the parameter as shown on the report. The time period that the parameter applies to needs to be clearly defined.

The Process Point represents the location in the process where the measurement is made. A single parameter or several parameters can be measured at a single Process Point. All report item parameters need to be linked to the Process Point where they were measured.

Location name represents the facility where the report data originates. For example, one location would be Wanapitei WTP.

3.2.3 Calculations Required in the Controller

For critical regulatory report items, calculations must be programmed in the PAC.

3.3 Data and Programs Backup and Disaster Recovery

The PAC and SCADA programs are backed up routinely by the City of Greater Sudbury SCADA Group, and saved on CDs. One copy is to be stored on site so it can be quickly reloaded in case any program becomes corrupt. A second copy is stored in a secure, off-site location for the purposes of Disaster Recovery. Any time these programs are modified, two copies of backups of the latest programs are to be made and labelled with new version numbers.

The Data Backup strategy primarily covers the data files that are created within the SCADA system, typically daily files and/or scheduled reports.

All data that is to be backed up is stored on the C:\ drive of the main HMI workstation and is to be located under the C:\iFIX_Public directory. The directory structure will exist and all files in the directory are to be backed up nightly.

The data files identified are to be backed up weekly and copied to SAN. All backup data is to be retained for one year.

3.4 Data Management Submittals

The following submittals must be made to the City:

1. List of SCADA tags for historical data collection
2. List of reports and definition of data to be included
3. Draft reports
4. Final reports

4 Submittals

Several submittals, involving hardware and software from the scope of this section of SCADA, Controls and Instrumentation Systems Design Standards are required throughout the course of a project. Refer to the summary of deliverables included in Section B - Automation System Project Delivery, Appendix B-1.

G-1 - Standard SCADA Computer Hardware Configuration Specification

G-2 - Sample SCADA Screens